4270A

BCD Programmable Power Source

Instruction Manual

FLUKE ®

WARRANTY

Notwithstanding any provision of any agreement the following warrenty is exclusive:

The JOHN FLUKE MFG. CO., INC., warrants eech instrument it menufectures to be free from defects in material and workmanship under normal use and service for the period of 1 yeer from dete of purchase. This warranty extends only to the original purchaser. This warranty shall not apply to fuses, disposable batteries (rechargeable type batteries are warranted for 90 days), or any product or parts which heve been subject to misuse, neglect, accident, or abnormal conditions of operations.

In the event of failure of a product covered by this warranty, John Fluke Mfg. Co., Inc., will repair end calibrate an Instrument returned to an authorized Service Facility within 1 year of the original purchase; provided the warrantor's examination discloses to its satisfaction that the product was defective. The warrantor may, at its option, replace the product in lieu of repair. With regard to any instrument returned within 1 year of the original purchase, said repairs or replacement will be made without charge. If the failure has been caused by misuse, neglect, accident, or abnormal conditions of operations, repairs will be billed at a nominal cost. In such case, an estimate will be submitted before work is started, if requested.

> THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIEO, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS, OR ADEQUACY FOR ANY PARTICULAR PURPOSE OR USE. JOHN FLUKE MFG. CO., INC., SHALL NOT BE LIABLE FOR ANY SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER IN CONTRACT, TORT, OR OTHERWISE.

If any failure occurs, the following steps should be taken:

> 1. Notify the JOHN FLUKE MFG. CO., INC., or nearest Service facility, giving full details of the difficulty, and include the model number, type number, and serial number. On receipt of this information, service data, or shipping instructions will be forwarded to you.
>
> 2. On receipt of the shipping instructions, forward the instrument, transportation prepeid. Repairs will be made at the Service Facility and the instrument returned, transportation prepaid.

SHIPPING TO MANUFACTURER FOR REPAIR OR ADJUSTMENT

All shipments of JOHN FLUKE MFG. CO., INC., instruments should be made via United Parcel Service or "Best Way"* prepaid. The instrument should be shipped in the original packing carton; or if it is not availeble, use any suitable container that is rigid and of adequate size. If a substitute container is used, the instrument should be wrapped in paper and surrounded with at least four inches of excelsior or similar shock-absorbing material.

CLAIM FOR DAMAGE IN SHIPMENT TO ORIGINAL PURCHASER

The instrument should be thoroughly inspected immediately upon original delivery to purchaser. All material in the container should be checked against the enclosed pecking list. The manufacturer will not be responsible for shortages egainst the packing sheet unless notified immediately. If the instrument is damaged in any way, a claim should be filed with the carrier immediately. (To obtain a quotation to repeir shipment damage, contact the nearest Fluke Technical Center.) Final claim and negotiations with the cerrier must be completed by the customer.

The JOHN FLUKE MFG. CO., INC, will be happy to enswer ell applications or use questions, which will enhance your use of this instrument. Please address your requests or correspondence to: JOHN FLUKE MFG. CO., INC., P.O. BOX C9090, EVERETT, WASHINGTON 98206, ATTN: Sales Dept. For European Customers: Fluke (Holland) B.V., P.O. Box 5053, 5004 EB, Tilburg, The Netherlands.

*For European customers, Air Freight prepaid.

John Fluke Mfg. Co., Inc., P.O. Box C9090, Everett, Washington 98206

Rev. 6/81

Table of Contents

TABLE OF CONTENTS, *continued*

Option −07 100 uV Resolution
Schematic Diagram 4210A-1032
Option −09, Multi-Strobe Isolated Logic
Schematic Diagram

Model A4200 Manual Control Unit
Schematic Diagram A4200-1000
Rack Mounting Fixtures
Programming Connector
Extender PCB Assembly and Cable Extender Assembly

List of Illustrations

LIST OF ILLUSTRATIONS, *continued*

Rev. 1

LIST OF ILLUSTRATIONS, *continued*

List of Tables

Section 1
Introduction & Specifications

1-1. INTRODUCTION

1-2. The Model 4270A is a programmable, bipolar dc voltage source and ac power amplifier. Output voltage is from 0 to ±110Vdc in two ranges, 10 and X10Vdc. Programming resolution using the internal reference voltage is 1mV on the 10 volt range and 10mV on the X10 volt range. Output accuracy is given in paragraph 1-6. After a 100μs settling time, a READY flag indicates that the output has settled to ±0.01% of the programmed level for a resistive load. The output current is rated at ±0.5 ampere maximum and is limited to approximately ±0.6 ampere in the event of an overload or short circuit. The sink current (milliamps) is rated at 500—4.5E $_{OUT}$ maximum. A Programmable Current Limiter (Option —06) is available to allow programming the maximum output current to a lower level. A current limit flag indicates when a sink or source current overload exists with or without the —06 Option.

1-3. Programming requirements are compatible with DTL or TTL logic levels. Contact or relay closures can also be used. The voltage source is programmable using BCD or binary-per-decade coding, using 8-4-2-1 format. All programming inputs and flag outputs are made through a 50-pin Amphenol, Blue Ribbon connector located on the rear panel. A +5Vdc output is also available at this connector and is used to provide power for external programming circuitry. Negative logic is employed for programming. The logic levels are as follows:

Logic "0" = +2.0Vdc to +5.0Vdc or open circuit.
Logic "1" = 0 to +0.4Vdc or short circuit to
LOGIC GND.

1-4. Four options are available and provide tailoring of the power supply to fit application requirements. These options are identified by numeric designations —03, —06, —07, and —09. Each option is described in Table 1-1. The options can be installed at the factory when the instrument is ordered or in the field at a later time.

1-5. This power source is completely solid state. Plug-in printed circuit boards, with accessible test points and adjustments, are provided for ease in servicing. The unit is forced-air cooled. This results in lower component temperatures and higher reliability than would normally be obtained in a source of this power capability. The chassis is designed for bench top use, or it can be installed in a standard equipment rack by using the Accessory Rack Mounting Fixtures.

Table 1-1. OPTIONS

OPTIONS	TITLE	DESCRIPTION
—03	EXTERNAL REFERENCE (Field Installable)	Allows the use of an external signal source in place of the internal reference voltage. Any dc or ac signal can be used that has an amplitude from 0 to ±14.5 volts dc or peak ac and a frequency from dc to 30 kHz. Input impedance is 100k, in parallel with 70pF.
—06	PROGRAMMABLE CURRENT LIMIT (Field Installable)	Programmable current limit is provided in two ranges, 50mA and 0.5 ampere. Each range may be programmed in 10% increments from 10% to 110% of range.
—07	100μV RESOLUTION (Field Installable)	The —07 Option provides 100μV resolution on the 10V range and 1mV on the X10V range.
—09	MULTI-STROBE ISOLATED LOGIC (Field Installable)	Permits any of the Fluke 4200 series Programmable Voltage Sources to be remotely controlled by a large variety of program sources such as a computer, a system coupler, as well as a Fluke Automatic Test Equipment System. Refer to Section 6 for details.

1-6.   SPECIFICATIONS

OUTPUT VOLTAGE . . . .   0 to ±9.999Vdc (BCD inputs)
0 to ±16.665Vdc (4-bit binary, by decade)
±99.99Vdc (BCD inputs)
±1100Vdc (4-bit binary, by decade)
(Maximum output terminal voltage = ±1100V)

OUTPUT VOLTAGE RESOLUTION . . . . .   10V range: 1.0mV (100μV option —07)
X10V range: 10mV (1mV option —07)

OUTPUT CURRENT . . . .   0 to ±0.5
(Short circuit protected at 0.6 ampere)

CURRENT SINK CAPABILITY . . . . I_{sink} (mA) = 500 - 4.5E_{out} (Overload protected)
Maximum voltage = ±110V

ACCURACY (15°C to 35°C, 90 days) . . . . .   10V range: ±(0.01% of program +100μV)
X10V range: ±(0.01% of program +700μV)

STEADY STATE RIPPLE AND NOISE . . . .   10V range: 2.1mV p-p 500μV rms
(10 Hz to 10 MHz bandwidth) . . . . . .   X10V range: 3.6mV p-p 1.2mV rms

SPEED . . . .   Settles to 0.1% of the programmed change in 80μs
Settles to 0.01% of the programmed change in 110μs. A range change does not increase settling time.

DIGITAL NOISE REJECTION . . . .   Noise between digital programming ground and the analog output is rejected 1000:1 (60db) at 1MHz

OUTPUT IMPEDANCE   . . . .   0.04 milliohms @ dc; 1 phm @ 30 kHz
EXTERNAL REFERENCE (Option —03)

    Voltage Range . . . .   0 to ±14.5Vdc or peak ac
    Input Impedance . . . .   100k ohms in parallel with 70 pF
    Output Voltage . . . .   10V range: 0 to 12V rms, ±17V peak
        X10V range: 0 to 78V rms, ±110V peak
    Output Current . . . .   350mA rms, 0.5 amp peak
    Frequency Range . . . .   dc to 30 kHz

Accuracy . . . . (15°C to 35°C, 90 days with respect to the External Reference, E_{XR})	10V range: $\pm(0.01\%$ of program $+.0001\%\ \dfrac{75}{E_{XR}} + 100\mu V)$ at dc X10V range: $\pm.0001\%\ \dfrac{75}{E_{XR}} +700\mu V$ at dc.
Programming Resolution	10V range: $E_{XR} \times 10^{-4}$ volts X10V range: $E_{XR} \times 10^{-3}$ volts
PROGRAMMABLE CURRENT LIMIT . . . . (Option −06)	50mA range: ±5mA to ±55mA in 5mA increments 0.5 amp range: ±50mA to ±0.55 amp in 50mA increments Minimum program possible: ±5mA
OUTPUT STABILITY	10V range: $\pm(10$ppm of program $+40\mu V)$ for 24 hours $\pm(30$ppm of program $+ 70\mu V)$ for 90 days X10V range: $\pm(10$ ppm of program $+280\mu V)$ for 24 hours $\pm(30$ppm of program $+490\mu V)$ for 90 days
TEMPERATURE COEFFICIENT . . . . . . (Temperatures between 15° and 35°C)	10V range: $\pm(10$ppm of program $+5\mu V$ per °C) X10V range: ±10ppm of program $+35\mu V$ per °C)
LOAD REGULATION	An output current change of 0.5 ampere causes the output voltage to change less than 0.001% of range
LOAD RECOVERY	The output voltage will settle to within 0.01% of final value in $110\mu s$ after an output current change of 0.5 ampere
LINE REGULATION	The output voltage will change less than 0.001% of range for a $\pm10\%$ change in line voltage
BARRIER STRIP TERMINALS	EXT REF LO, EXT REF HI, OUTPUT HI, SENSE HI, SENSE LO, OUTPUT LO, GUARD and CHASSIS. Terminals are located on the rear panel. The GUARD terminal can be floated up to 1000 volts above chassis ground.
PROGRAMMING CONNECTOR . . . . . . (See Table 1-3)	A 50-pin connector is located on the rear panel. Mating connector is Amphenol, Blue Ribbon, Part No. 57-30500, and is included with each power source.
INPUT POWER	100/115/125/200/230/250Vac $\pm10\%$ 50 to 60 Hz, 200 watts fully loaded
ENVIRONMENTAL	
Temperature	0°C to 50°C operating; −40°C to 75°C storage
Relative Humidity	0 to 80%
Shock	20G, 11 millisecond half-sine wave
Vibration	4.5G, 10 to 55 Hz
Altitude	0 to 10,000 feet operating 50,000 feet and above-non-operating
SIZE (See Figure 1-1)	5 ¼" high x 17" wide x 19 7/16" (Max.) deep
ACCESSORIES	
Manual Control Unit	Allows manual checkout, calibration, and control FLUKE Model A4200
Rack Mounting Brackets	■ M05-205-600 ■ M00-260-610 (18") ■ M00-280-610 (24")
Programming Mating Connector	Amphenol, Blue Ribbon 57-30500 FLUKE PART NO. 266056
Extender PCB Assembly	FLUKE PART NO. 292623
Cable Extender Assembly	FLUKE PART NO. 337584

FRONT VIEW   SIDE VIEW
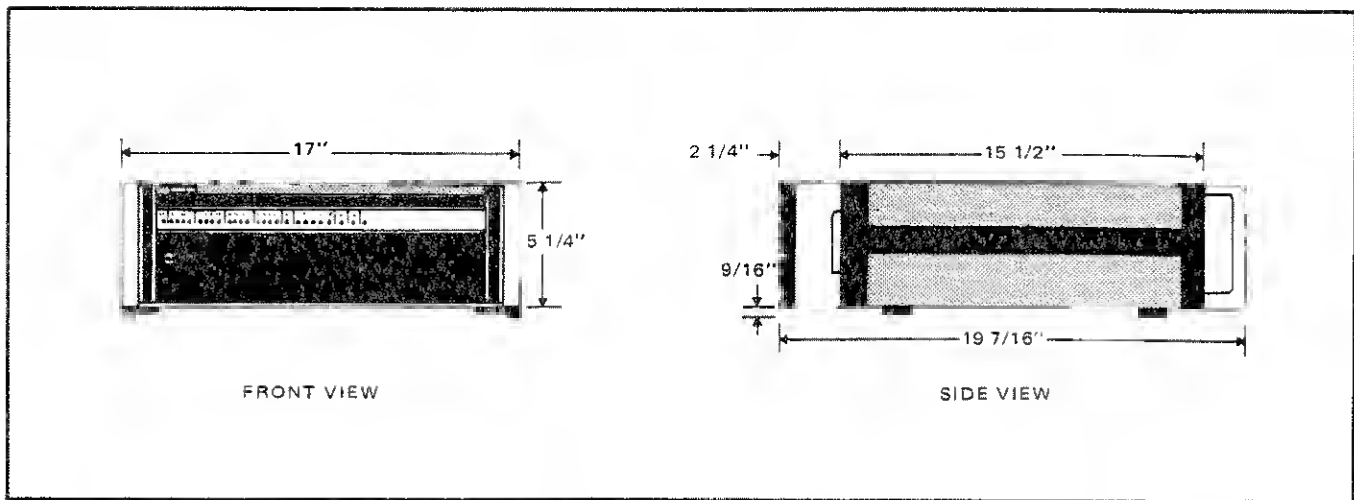
Figure 1-1. OUTLINE DRAWING

Table 1-2. PROGRAMMING INPUT/OUTPUTS

PROGRAM CONTROL:	All program control and response lines are compatible with DTL and TTL logic. Programming lines are brought out on the rear panel on Amphenol connector J1. See Figure 1-2.
LOGIC LEVELS:	Logic "1" = 0 +.4Vdc or contact closure Logic "0" = +2.0 to +5.0Vdc or open circuit
SIGN:	Connector Pin 35 Logic "1" = Negative output voltage
MAGNITUDE:	<table><tr><td>Bit Wt.</td><td>Conn. Pin</td><td>Bit Wt.</td><td>Conn. Pin</td><td>Bit Wt.</td><td>Conn. Pin</td></tr><tr><td>A^8</td><td>1</td><td>C^8</td><td>9</td><td>E^8</td><td>43</td></tr><tr><td>A^4</td><td>2</td><td>C^4</td><td>10</td><td>E^4</td><td>44</td></tr><tr><td>A^2</td><td>3</td><td>C^2</td><td>11</td><td>E^2</td><td>45</td></tr><tr><td>A^1</td><td>4</td><td>C^1</td><td>12</td><td>E^1</td><td>46</td></tr><tr><td>B^8</td><td>5</td><td>D^8</td><td>13</td><td></td><td></td></tr><tr><td>B^4</td><td>6</td><td>D^4</td><td>14</td><td colspan="2">(—07 Option)</td></tr><tr><td>B^2</td><td>7</td><td>D^2</td><td>15</td><td></td><td></td></tr><tr><td>B^1</td><td>B</td><td>D^1</td><td>16</td><td></td><td></td></tr></table> NOTE: Decade numbers greater than 9 (10 thru 15) will be accepted and converted to an equivalent analog value. The maximum full scale output is ±110Vdc.
DATA STROBE:	Connector pin 33. When using the Isolated Control Logic Option —01, a strobe pulse is required to start the digital-to-analog conversion process after a valid command is present. Minimum pulse width is 500 nanoseconds. A negative leading slope (+5V to 0V transition) is required.
RANGE:	Connector Pin 29; Logic "0" = Low Voltage Range, Logic "1" = High Voltage Range.
EXTERNAL REFERENCE:	Connector Pin 36; Logic "0" = Internal DC Reference, Logic "1" = External Reference.
STANDBY:	Connector Pin 34; Logic "0" = Operate Mode, Logic "1" = Standby; Output is ≈ 1% of programmed value.

Table 1-2. PROGRAMMING INPUT/OUTPUTS

CURRENT LIMIT:	Connector Pin	Function	Logic "1"	Logic "0"
	42	Range	0.5 amp	50mA
	43	Magnitude	80% of Range	0 All "0"s =
	44	Magnitude	40% of Range	0 10% of range
	45	Magnitude	20% of Range	0
	46	Magnitude	10% of Range	0
RESPONSE SIGNALS:				
CURRENT LIMIT FLAG:	Connector Pin 49;	Logic "1" represents a current limit condition.		
READY/NOT READY FLAG:	Connector Pin 37;	Logic "0" = "Ready" condition following a 110µs delay to allow the output to settle to within 0.01% of the programmed increment for a resistive load.		
READY/NOT READY FLAG:		Logic "1" = "Not Ready" condition, the power source is in the process of settling to the programmed value.		
POWER CONNECTIONS:	Connector Pin 25;	An internal, isolated power supply furnishes +5Vdc current limited by 2.7 ohms for use by the external system interface logic.		
LOGIC GROUND:	Connector Pins 17 thru 24;	It is recommended that a large logic ground strap be used between the interface logic and the power source to reduce the digital programming noise on the system ground.		
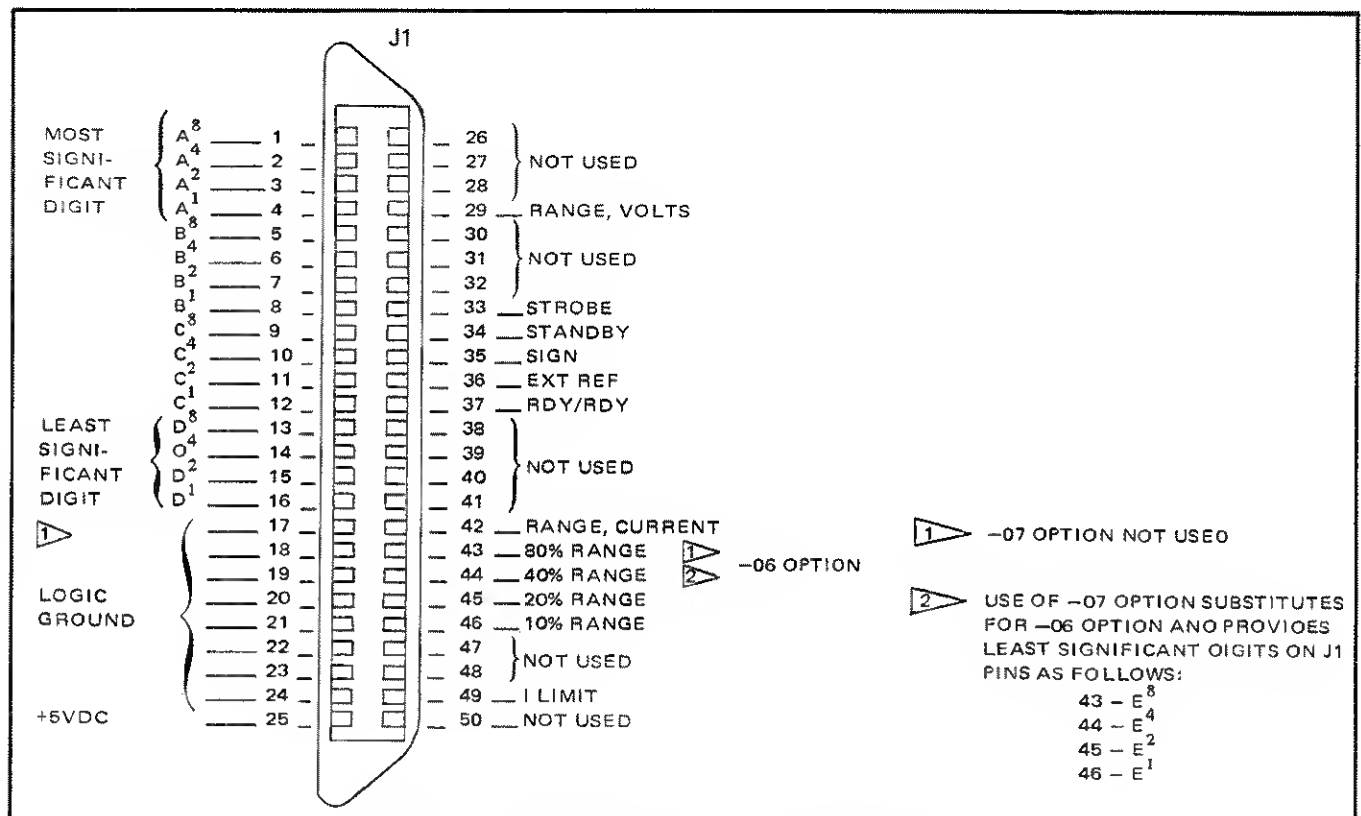
Figure 1-2. PROGRAMMING CONNECTOR PIN ASSIGNMENTS

static awareness
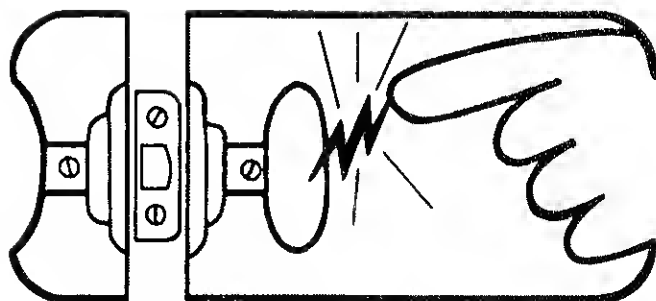
Some semiconductors and custom IC's can be damaged by electrostatic discharge during handling. This notice explains how you can minimize the chances of destroying such devices by:

1. Knowing that there is a problem.
2. Learning the guidelines for handling them.
3. Using the procedures, and packaging and bench techniques that are recommended.

The Static Sensitive (S.S.) devices are identified in the Fluke technical manual parts list with the symbol " ⊗ "

The following practices should be followed to minimize damage to S.S. devices.
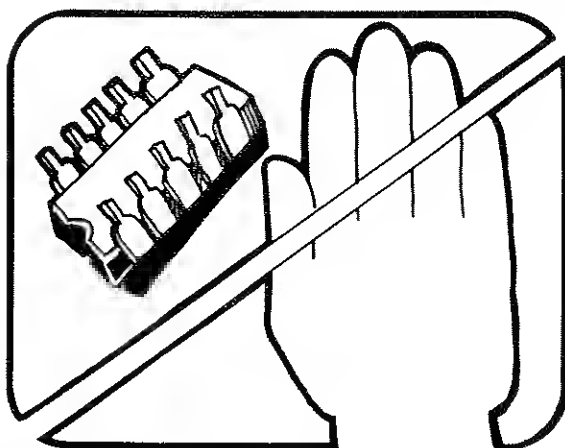
1. MINIMIZE HANDLING
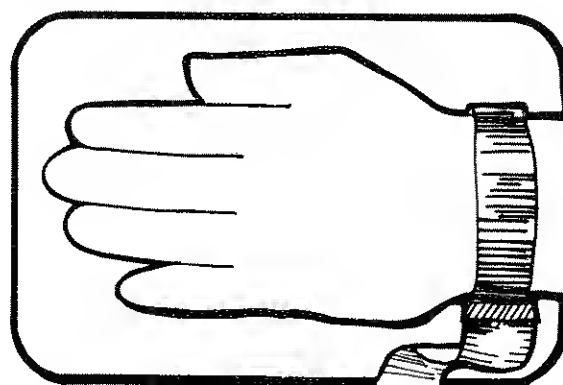
3. DISCHARGE PERSONAL STATIC BEFORE HANDLING DEVICES
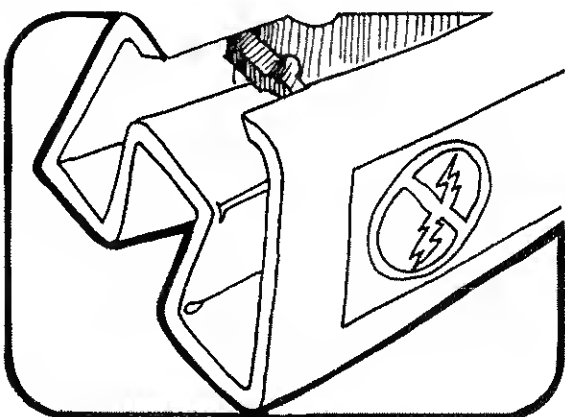
2. KEEP PARTS IN ORIGINAL CONTAINERS UNTIL READY FOR USE.
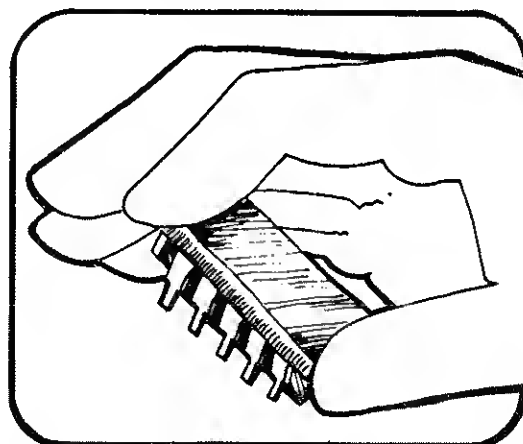
4. HANDLE S.S. DEVICES BY THE BODY
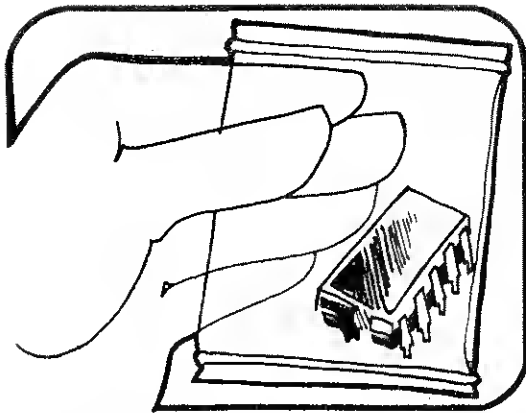
5. USE ANTI-STATIC CONTAINERS FOR HANDLING AND TRANSPORT
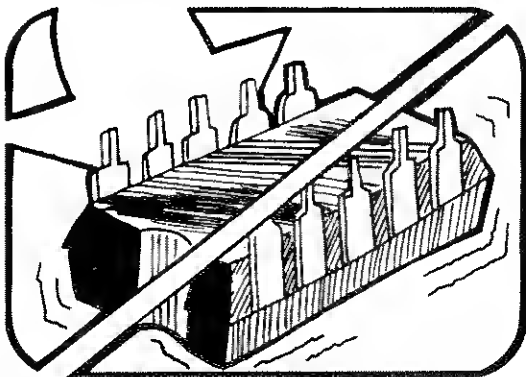
6. DO NOT SLIDE S.S. DEVICES OVER ANY SURFACE
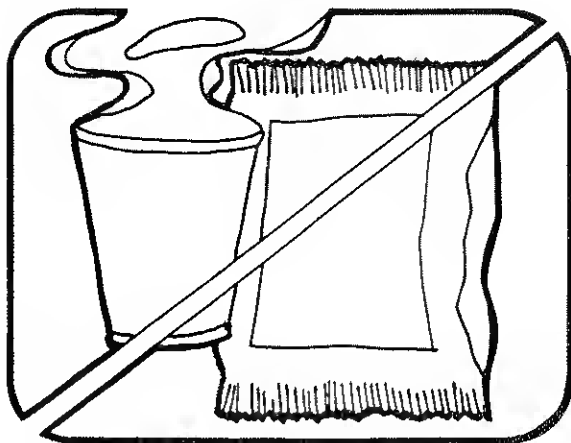
7. AVOID PLASTIC, VINYL AND STYROFOAM® IN WORK AREA

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AND GENERAL DYNAMICS, POMONA DIV.
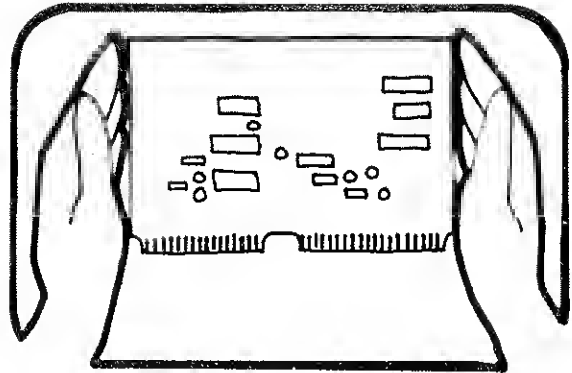
8. WHEN REMOVING PLUG-IN ASSEMBLIES, HANDLE ONLY BY NON-CONDUCTIVE EDGES AND <u>NEVER</u> TOUCH OPEN EDGE CONNECTOR EXCEPT AT STATIC-FREE WORK STATION. PLACING SHORTING STRIPS ON EDGE CONNECTOR USUALLY PROVIDES COMPLETE PROTECTION TO INSTALLED SS DEVICES.
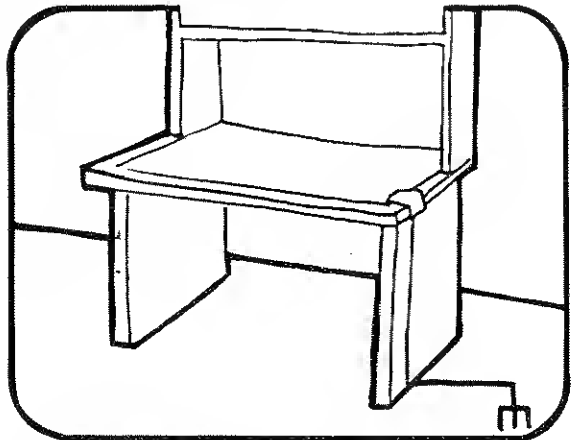
9. HANDLE S.S. DEVICES ONLY AT A STATIC-FREE WORK STATION

10. ONLY ANTI-STATIC TYPE SOLDER-SUCKERS SHOULD BE USED.

11. ONLY GROUNDED TIP SOLDERING IRONS SHOULD BE USED.

Anti-static bags, for storing S.S. devices or pcbs with these devices on them, can be ordered from the John Fluke Mfg. Co., Inc.. See section 5 in any Fluke technical manual for ordering instructions. Use the following part numbers when ordering these special bags.

John Fluke Part No.	Description
680892	5" x 8" Bag
680934	8" x 10" Bag
680942	8" x 12" Bag
680983	12" x 16" Bag
681023	18" x 18" Bag
Pink Poly Sheet	Wrist Strap
30" x 60" x 60 Mil	P/N TL6-60
P/N RC-AS-1200	$7.00
$20.00	

Section 2
Operating Instructions

2-1.   INTRODUCTION

2-2.   This section contains information regarding install-
ation and operation of the Model 4270A. It is recommended
that the contents of this section be read and understood be-
fore any attempt is made to operate this power source.
Should any difficulties be encountered during operation,
please contact your nearest John Fluke Sales Representative,
or the John Fluke Mfg. Co., Inc., P.O. Box 43210, Mount-
lake Terrace, Washington 98043, telephone (206) 774-2211.
A list of Sales Representatives is located in Section 7 of this
manual.

2-3.   SHIPPING INFORMATION

2-4.   The Model 4270A was packaged and shipped in a
foam-packed cardboard carton. Upon receipt, a thorough
inspection should be performed to reveal any instrument
damage incurred in transit. Special instructions for inspec-
tion and claims are included in the carton.

2-5.   If reshipment of this power source is necessary, the
original container should be used. If the original container is
not available, a new one can be obtained from the John Fluke
Mfg. Co., Inc. Please reference the Model number when re-
questing a new shipping container.

2-6.   INPUT POWER

2-7.   This power source can be operated from a 50 to
60 Hz power line ranging from 100 to 250 volts ac. A decal
on the rear panel indicates the power input limits. Specific
power line voltages require that slide switches internal of the
instrument be set as indicated in Figure 2-1 or on the lower
left corner of the guard cover. To accommodate the instru-
ment to the specific power line voltage, proceed as follows:

LINE	SWITCH POSITIONS		
VOLTAGE	PWR SPLY	H – V PWR SUPPLY	
	(A2) S1	(A10) S1	(A10) S2
100	WHT	WHT	RED
115	WHT	RED	WHT
125	WHT	RED	RED
200	RED	WHT	RED
230	RED	RED	WHT
250	RED	RED	RED

Figure 2-1. INPUT POWER SWITCHING

a.   Determine the ac line voltage and relate its value
to the closest value shown in Figure 2-1. Remove
the power cord.

b.   Remove the top cover of the instrument.

c.   Remove the top inner guard cover.

d.   Refer to Figure 2-2 and locate the three slide
switches in the instrument.

e.   Refer to Figure 2-1 and set the three power switch-
es such that the color dot showing corresponds to
the color given for the specific line voltage that
was selected in step a.

f.   Refer to the decal on the rear panel of the instru-
ment, determine the appropriately rated fuse for
the line power selected in step a., and install the
fuse in the fuse holder.
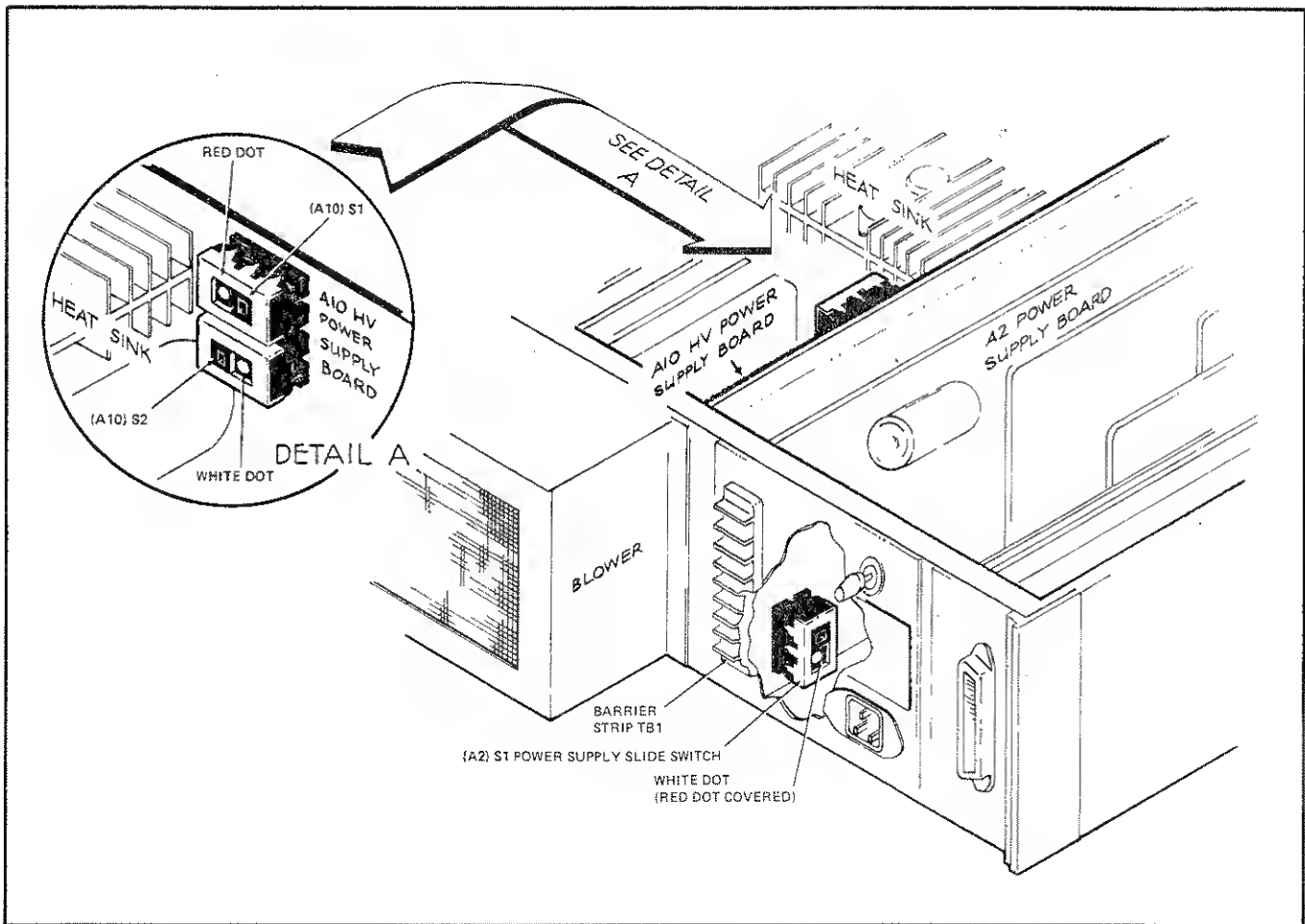
Figure 2-2. POWER SUPPLY SWITCH LOCATION

g.   With the power switch off (down), connect the ac
       power cord and turn on the power switch. Check
       that the POWER indicator on the front panel illu-
       minates.

h.   Turn off power switch and assemble guard and top
       cover in reverse order of removal.

2-8.   RACK INSTALLATION

2-9.   The power source is designed for bench-top use
or for installation in a 19-inch equipment rack using the
accessory rack mounting kit shown in Figure 2-3. Accessory
chassis slides can also be installed to better facilitate rack
installation. Information regarding installation of these
accessories is given into the Section 6, Accessory Rack Mount-
ing Fixtures.

2-10.   OPERATING FEATURES

2-11.   The location and function of all connectors and in-
dicators is given in Figures 2-4 and 2-5.
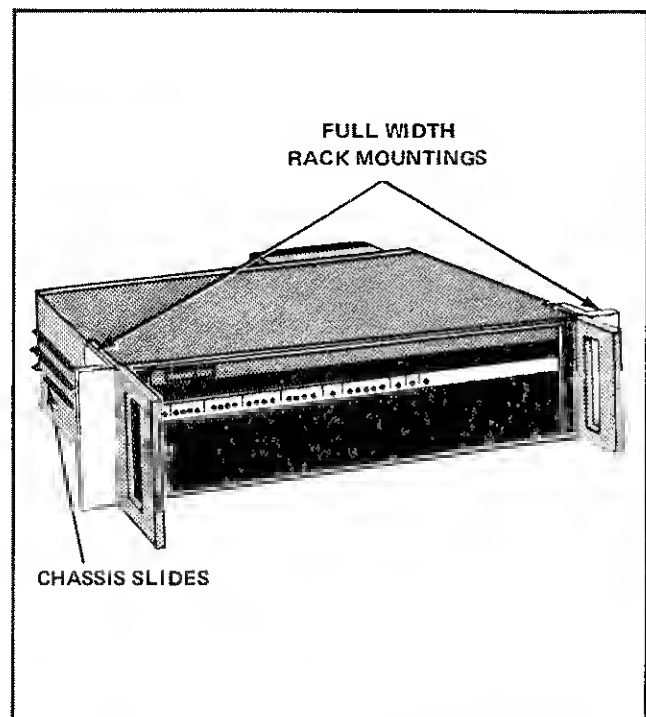
Figure 2-3. ACCESSORY RACK MOUNTING KITS

2-2

STATUS INDICATORS (–02 OPTION ONLY)
Illuminate to indicate the programmed level and status of the power source

POWER INDICATOR   Illuminates when the power source is energized
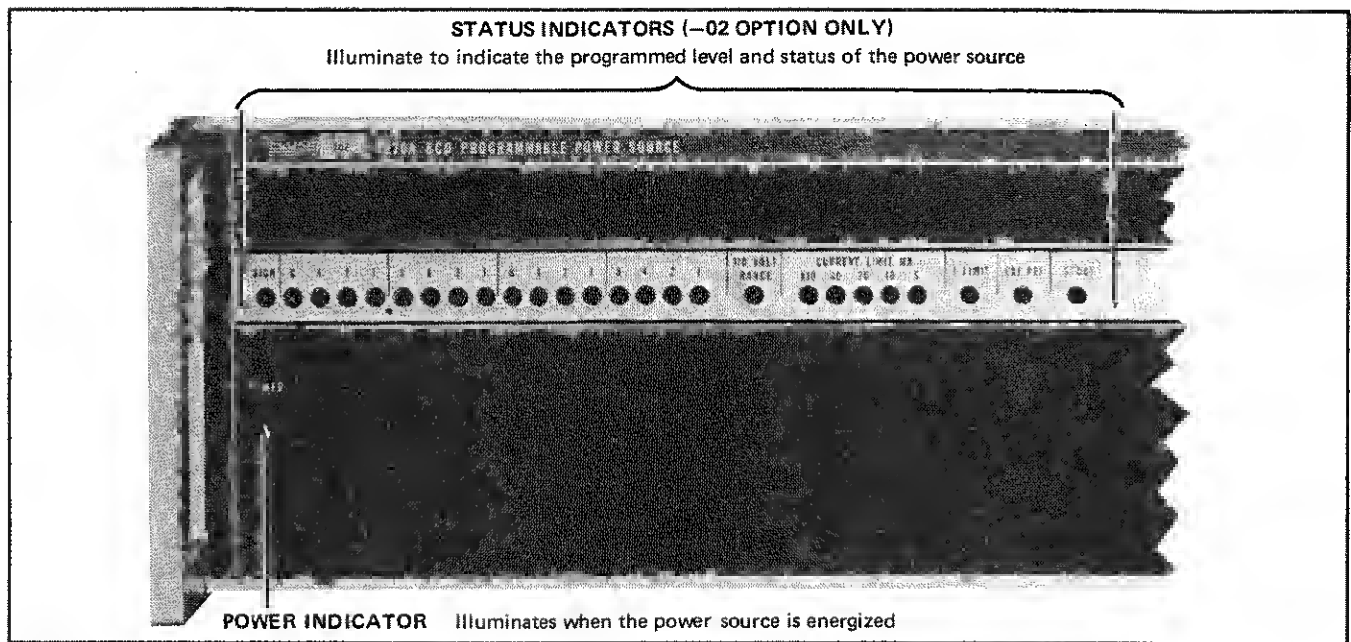
Figure 2.4 FRONT PANEL OPERATING FEATURES

BARRIER STRIP
Contains the analog input/output terminals.

EXT REF (–03 Option)
Receives a 0 to ±14.5 Vdc or peak ac signal having a frequency from dc to 30 kHz. Input resistance is 100k. See para 2-42.

± SENSE TERMINALS
Provide four terminal load connection. See para 2-18.

POWER SWITCH
Toggle switch used to energize the power source. A POWER indicator on the front panel illuminates when the power source is energized.

AIR FILTER

± OUTPUT TERMINALS
Provide connection to the load. See para 2-16.

GUARD TERMINAL
Provides for load connections that reduce errors caused by common mode signals. See para 2-22.

CHASSIS TERMINAL
Provides connection to chassis and earth ground. See para 2-20.

POWER CONNECTOR
Provides connection through the power cord to line power.

PROGRAMMING CONNECTOR, FEMALE, AMPHENOL
Contains the digital input/output connections required for programming. An accessory mating connector (not shown) is provided.

FUSE
Protects the ac input circuitry.

100, 115, 125VAC	2A, AGC
200, 230, 250VAC	1A, AGC

Figure 2-5. REAR PANEL OPERATING FEATURES

2-12. OPERATING NOTES

2-13.   The following paragraphs describe various conditions which should be considered before operating the Model 4270A.

2-14. AC Line Connection

2-15.   The input power cord plug is a three prong, polarized connector. This plug allows connection to a 100 to 250 volts ac, 50 to 60 Hz, power line (see Input Power, paragraph 2-6), and connects the power source chassis to earth ground. Always ensure that the ground pin is connected to a high quality earth ground. The power source is energized through a toggle switch on the rear panel.

2-16. Load Connections

2-17.   An eight terminal barrier strip, located on the rear panel, serves as an analog input/output connector for the power source. The ± power output terminals (OUTPUT HI and LO) provide connection to the load. The ±sense terminals (SENSE HI and LO) are provided to allow remote sensing at the load. The sense terminals are bussed through jumpers installed at the factory to the output terminals. If remote sensing is not required,the load is connected to the respective ± output terminals and the sensing busses are not removed. If remote sensing is required, the busses must be removed and separate sense lines provided between the sense terminals and the load. In either case, NEVER operate the power source with the sense terminals disconnected. The CHASSIS terminal is connected directly to the chassis and allows grounding of the load through the input power cord, if desired. The GUARD terminal allows load connections that can greatly reduce errors caused by common mode signals. This guard connection should always be used if optimum noise free performance is to be achieved.

2-18. Remote Sensing

2-19.   When a load is connected to the OUTPUT terminals, the I-R drop across the output power leads may be excessive in some applications. If the rated accuracy of the power supply is required at the load, remote sensing must be used. For this reason, SENSE HI and SENSE LO terminals are provided to allow the power supply output to be sensed directly at the load, thus compensating for any I-R drop in the output power leads. Figure 2-6 shows an example of remote sensing load connections.

NOTE!

The two jumpers on the barrier strip which bus ± output must be removed for remote sensing. When remote sensing, always use a twisted pair P of insulated wire from the output and sense terminals to the load. A maximum of 0.35

volts (at 25°C, decreasing 0.002 volts per degree C at higher temperatures) is allowable between either output terminal and its corresponding sense terminal. The leads between the output and sense terminals and the load must be large enough to carry the load current of up to 0.5 ampere and the sense current of about 1mA without exceeding this voltage.
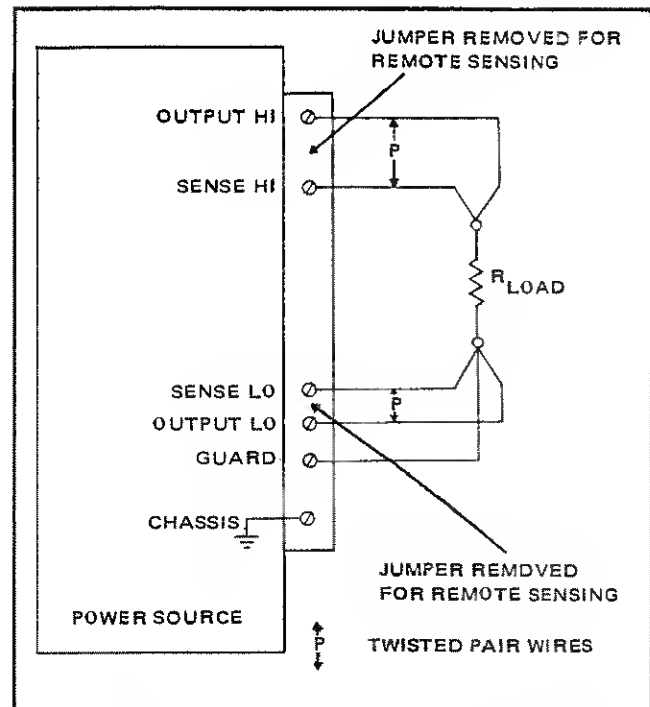
Figure 2-6. REMOTE SENSING CONNECTIONS

2-20. Ground Connections

2-21.   A CHASSIS terminal is provided at the rear panel. This terminal is directly connected to the chassis of the power source and earth ground through the ground pin on the input power plug. If grounding of the load is desired, this terminal provides a convenient connection to earth ground. When a guarded output (explain in paragraph 2-22) is not desired, this terminal should be connected to the GUARD terminal.

2-22. Guard Connections

2-23.   The power source is equipped with a guard shield that isolates its internal circuitry from the chassis and ground. A GUARD terminal at the rear panel is connected to this shield and allows load connections that greatly reduce errors caused by common mode signals. The guard may be driven to a maximum of 1000 volts above chassis ground. Figure 2-7 shows a simplified diagram of a guarded load connection.

2-24. PROGRAMMING INFORMATION

2-25.   All instrument functions, with the exception of ac power switching and control, are controlled via a mating pair of 50-pin Amphenol connectors located on the instrument rear panel. The female Amphenol connector is rigidly attached to the rear panel and a mating male connector, less cabling, is supplied with each instrument as a separate accessory. These Amphenol connectors establish the interface between the instrument and the programming equipment. Cabling is to be provided by the instrument user who determines pin utilization and cable length to satisfy his individual requirements. The instrument is powered via a rear panel toggle switch and not through the programming connector. Table 2-1 is a tabular listing that functionally describes each connector pin. Cable/connector assembly data is given in Section 6, Accessory Programming Connector.

2-26.   Programming input requirements are compatible with either DTL or TTL logic levels. Logic "0" is +2.0 to 5.0Vdc or open circuit to logic ground. Logic "1" is 0 to +0.4Vdc or short circuit to logic ground. Logic ground is available at pins 17 through 24 of the programming connector. Shorting these lines to the appropriate pins of the programming connector using contact closures also allows control of the power source. The internal +5Vdc output, current limited by 2.7 ohms, is available at pin 25 for use by the external programming logic.

2-27.   Standby

2-28.   The STANDBY mode can be programmed by applying a Logic "1" to pin 34 of the programming connector. When this condition exists, the output of the power source will be driven to less than 1% of the programmed value. Application of a logic "0" at this pin returns the output voltage to the programmed level.

2-29.   Range/Output Magnitude/Polarity

2-30.   Two voltage ranges are available; ±10 volts and ±X10 volts. The RANGE is programmed by a single binary input at pin 29 of the programming connector. A Logic "0" applied to this pin will program the ±10 volt range, and a Logic "1" will program the ±X10 volt range. The power supply is capable of an output of ±110Vdc minimum at ±0.55 ampere.

2-31.   The magnitude of the output voltage is programmed by applying either BCD or four bit binary-per-decade coding, using 8-4-2-1 format, to pins 1 through 16 of the program connector. Four decades of programmable voltage are available; each receives a four-bit 8-4-2-1 coded input. The maximum program of any decade is (8+4+2+1) 15, which provides a total output program of ±16.665 volts on the 10 volt range with a programmable resolution of 1mV. If BCD coding is used, the maximum programmable output on the 10 volt range is ±9.999 volts. When using the X10

C1   = CIRCUITRY TO GUARD CAPACITANCE
C2   = GUARD TO CASE CAPACITANCE
E_{cm} = COMMON MODE VOLTAGE
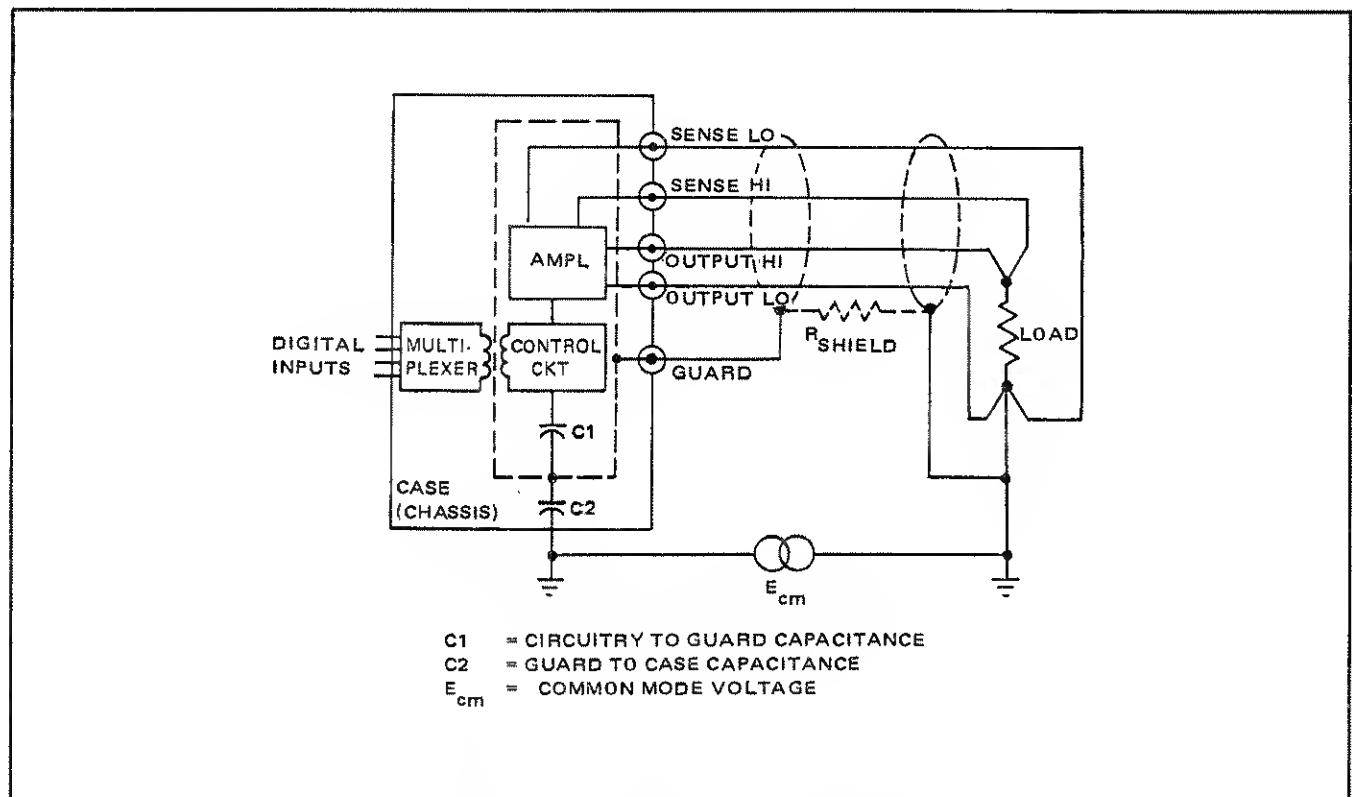
Figure 2-7. GUARDED LOAD CONNECTION

Table 2·1. PROGRAMMING CONNECTOR DATA

LOGIC "0" = +2.0 to +5.0Vdc or open circuit
LOGIC "1" = 0 to +0.4Vdc or short circuit to LOGIC GRD

PIN NO.	FUNCTION		
	CODE		
1	8	A DECADE:	1V·10V range
2	4		10V·100V range
3	2		
4	1		
5	8	B DECADE:	1V-10V range
6	4		1V-100V range
7	2		
8	1		
9	8	C DECADE:	0.01V-10V range
10	4		0.1V·100V range
11	2		
12	1		
13	8	D DECADE:	0.001D-10V range
14	4	$\boxed{1}\!\!\!\!>$	0.01V-100Vrange
15	2		
16	1		
17			
18			
20			
21	LOGIC GRD		
22			
23			
24			
25	LOGIC PWR (+5Vdc, current limited by 2.7 ohms internally)		
26			
27	NOT USED		
28			
29	RANGE: LOGIC "0" = 10 VOLT Range (±16.665V max) LOGIC "1" =100 VOLT Range (±110V max)		
30			
31	NOT USED		
32			
33	DATA STROBE (—01 Option) (See Figure 2-8) INITIATES DIGITAL TO ANALOG CONVERSION		
34	STANDBY/OPERATE: LOGIC "0" = OPERATE LOGIC "1" = STANDBY		
36	EXTERNAL REFERENCE (-03 Option): LOGIC "0" = INTERNAL REFERENCE LOGIC "1" = EXTERNAL REFERENCE		
37	READY/NOT READY FLAG: LOGIC "0" = READY LOGIC "1" = NOT READY		
38			
39	NOT USED		
40			

41	CURRENT LIMIT: (—06 Option) $\boxed{2}\!\!\!\!>$		
42	Function	Logic "0"	Logic "1"
43	Range	100mA	1 amp
44	Magnitude	0 (All "0"s =	80% of range
45	Magnitude	0 10% of range)	40% of range
45	Magnitude	0	20% of range
46	Magnitude	0	10% of range
47			
48	NOT USED		
49	CURRENT OVERLOAD FLAG: LOGIC "0" = NORMAL LOGIC "1" = OVERLOAD (Over-Current)		
50	NOT USED		

$\boxed{1}\!\!\!\!>$ Least significant digit when —07 Option (100μV Resolution) is not used.

$\boxed{2}\!\!\!\!>$ Use of —07 Option substitutes for —06 Option and provides least significant digits in an E Decade; i.e., E^8, E^4, E^2, E^1.

volt range, which has a program resolution of 10mV, it should be noted that the maximum input program can exceed the output voltage capability of the power source. The maximum program using four bit binary-per-decade coding in 8-4-2-1 format is ±166.65 volts, while BCD coding provides a maximum program of ±99.99 volts. The maximum output voltage, however, is ±110 volts.

2-32.   Polarity of the output is controlled by a single input (SIGN) at pin 35 of the program connector. A Logic "0" will produce a positive output. A Logic "1" will produce a negative output.

2-33.   Data Strobe

2-34.   The DATA STROBE shown in Figure 2-8 is required to initiate the transfer of the data present at the programming inputs to the internal memory of the Isolated Control Logic (—01 Option). The DATA STROBE is applied to pin 33 of the programming connector. Upon its negative transition, program data transfer begins. At the same time, two pulses are generated; 15μs and 110μs. The 15μs pulse holds the power supply output at its previously programmed level while new data is transferred into memory and allowed to settle. At the end of the 15μs pulse the power source is allowed to respond to the new program data. The 110μs pulse provides a NOT READY flag output that indicates the power source has not had time to respond to new program data and for the output to be within ±0.01% of the programmed change for a resistive load. Program data must be present and settled for a minimum of 2.4μs after the negative transition of the DATA STROBE.

NOTE!

When the power supply is initially turned on or if a power interruption occurs, the power supply is programmed to zero volts, where it will remain until new data is transferred.

2-35. Flag Outputs

2-36.   Two flag outputs are provided to indicate when a current overload exists and when the output voltage has had time to settle. A current limited condition (I LIMIT) is indicated by a Logic "1" at pin 49 of the programming connector. Normal operation is indicated by a Logic "0". Output settling time is indicated by a NOT READY flag at pin 37. Logic "0" is the ready condition and indicates that the output voltage has had time to settle to within 0.01% of the programmed change for a resistive load. A Logic "1" indicates a not ready condition.

2-37.   The I LIMIT flag and the NOT READY flag sill both be activated when a sink or source current overload occurs. After the overload is removed, the I LIMIT flag will return to normal but the NOT READY flag will remain for 110μs to allow for output settling time. Figure 2-8 and 2-9 show the timing relations of these flags. If the Programmable Current Limiting (–06 Option) is installed, the I LIMIT flag will also be activated when current limiting occurs.

2-38.   Programmable Current Limiting

2-39.   When the Programmable Current Limiter (–06 Option) is installed, two ranges of current limiting are available; ±0.5 amp and ±50mA. The CURRENT LIMIT MA range is programmed by a single binary input at pin 42 of the programming connector. A Logic "0" applied to this pin programs the 50mA range and a Logic "1" programs the 0.5 amp range.

2-40.   The magniutde of the output current is programmed by applying either BCD or binary coding to pins 43 through 46 of the programming connector. Current magnitude programming is in increments of 10% of the programmed range. If all current magnitude inputs are programmed to Logic "0", the current limit is still 10% of the programmed range. The maximum current limit that can be programmed is 110% of the programmed range. When current limiting occurs, the I LIMIT flag changes from Logic "0" to Logic "1" as described in paragraph 2-37.

NOTE!

A sink capability greater than the programmed current limit value cannot be realized.

2-41.   External Reference

2-42.   When the External Reference (–03 Option) is installed, a single programming bit is used to remove the in-
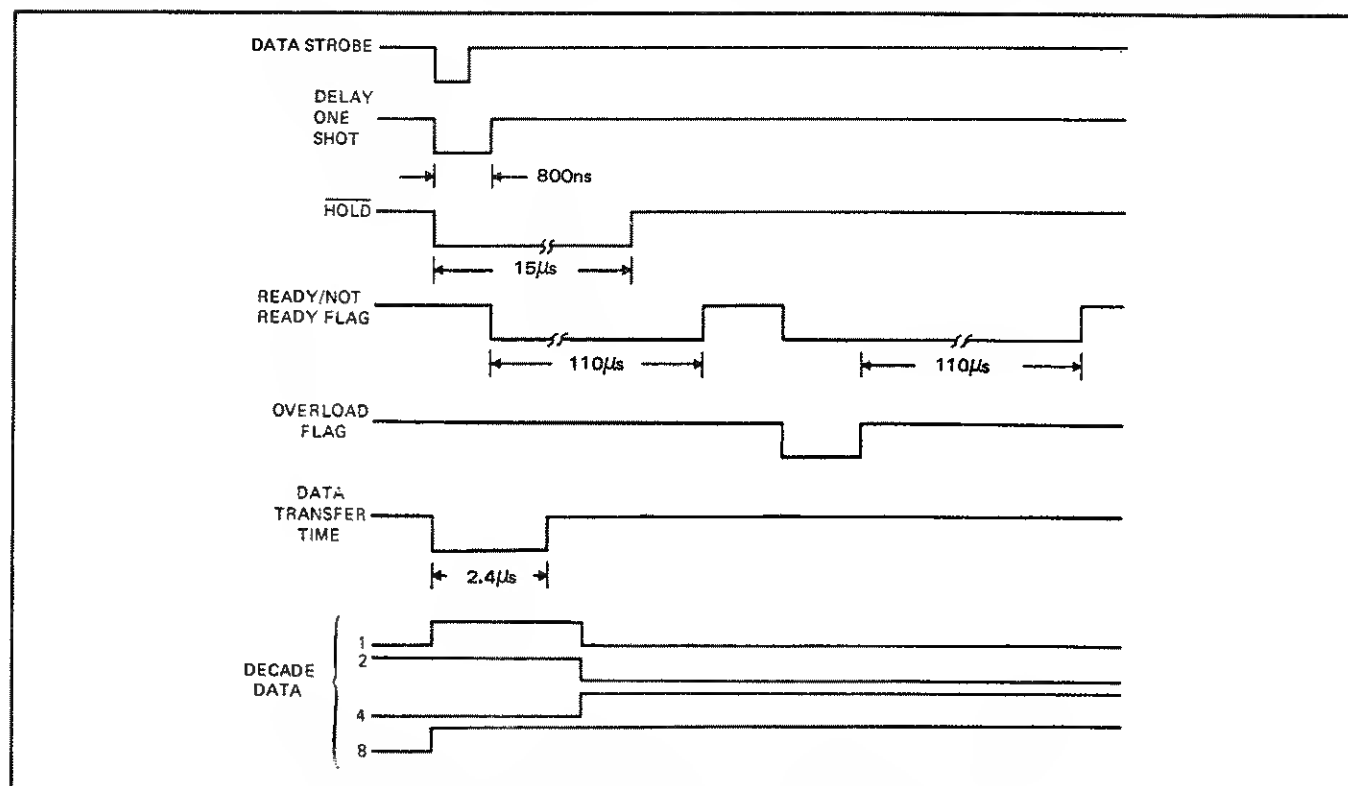
Figure 2-8. ISOLATED CONTROL LOGIC TIMING (–01 OPTION)

ternal 10Vdc reference from the D-to-A ladder network and switch in an external signal source to replace it. The output accuracy and stability of the power source, however, is then relative to the accuracy and stability of the external signal source.

2-43.   The external reference may be any dc or ac signal with an amplitude between 0 and ±14.5Vdc or peak ac (volts rms x 1.414) and have a frequency between dc and 30kHz. It is applied to the external reference terminals located on the rear panel barrier strip. The input imped-ance at these terminals is 100k ohms in parallel with 70pF. The external reference is programmed by applying a Logic "1" to pin 36 of the programming connector. It should be noted that the polarity of the output will be the same as the external reference regardless of the SIGN (polarity) pro-grammed.

2-44.   Programming the magnitude of the output voltage with a ±10 volt external reference is accomplished by the same method used for programming with the internal ref-erence voltage. (See paragraph 2-31). However, if the external reference is not exactly ±10 volts, the magnitude of the programming word required to obtain a specified out-put voltage must be calculated as follows:

MPW = Magnitude of the programming word

Eout = Output voltage (Vdc)

EXT REF = External reference voltage.

10 volt range:
$$MPW = \frac{Eout}{EXT\ REF} \times 10^4$$

Programming resolution = EXT REF ÷ 10

100 volt range:
$$MPW = \frac{Eout}{EXT\ REF} \times 10^4$$

Programming resolution = EXT REF ÷ 10^3 Note: Eout $\leqslant 110$V

It should be noted that the rated output of the power sup-ply is ±110V maximum at 0.55 ampere. It therefore be-comes obvious that when using the X10 volt range, the pro-gramming word can easily exceed the output capability of the power supply. The following example, using the pre-viously shown formula for the X10 volt range, illustrates this.

Example:

Find: Eout

Given: EXT REF = 14.5Vdc   EXT REF @ 14.5Vac
          MPW (BCD) = 9999.   MPW (BCD) = 9999
          Range = 110 volts   Range = 110 volts

$$MPW = \frac{Eout}{EXT\ REF} \times 10^3$$
$$\therefore Eout = MPW \times EXT\ REF \div 10^3$$
$$Eout = 9999 \times +14.5Vdc \div 10^3$$
$$Eout = +144.9855Vdc$$

Eout in this example greatly exceeds the rated 110 volt out-put capability of the power supply. To avoid this situation always calculate MPW with Eout $<$ 110Vdc or peak ac.

2-45.   Front Panel Indicators

2-46.   When the Front Panel Display (–02 Option) is in-stalled, status indicators (light emitting diodes) are provided on the front panel. They indicate the programmed output voltage level, output polarity, current overload, current limit levels, external reference, and standby status of the in-ternal register. None of these indicators are provided when the Blank Front Panel (–05 Option) is installed. A POWER indicator is included with either option to indicate that the power is on.

2-47.   Dynamic Characteristics

2-48.   The power source output can be changed quite rapidly with high speed programming information. How-ever, a 100μs period must be allowed before the output has settled to its stated accuracy for a resistive load.

2-49.   When an external signal is used as the reference for the power source, the output accuracy is dependent upon the characteristics of the external signal. If a dc voltage is used, the output accuracy is related to the accuracy and stability of the external voltage. However, if an ac signal is used, the output accuracy is not only dependent upon the external signal stability, but also its frequency. Typical examples of accuracy versus frequency are shown in Figure 2-9 through 2-12.
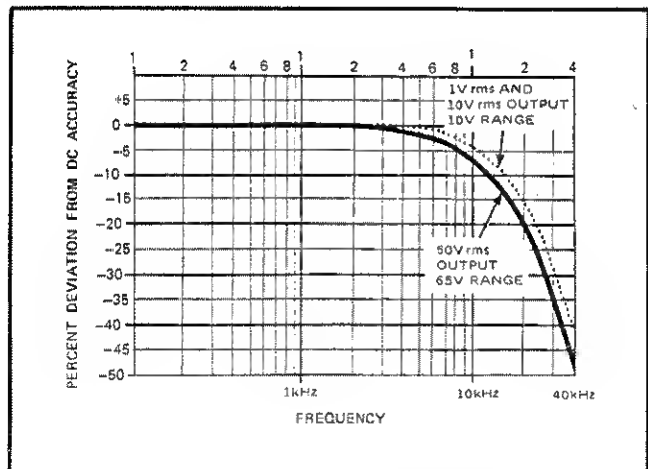
Figure 2-9. ACCURACY VERSUS EXTERNAL RE-
REFERENCE FREQUENCY
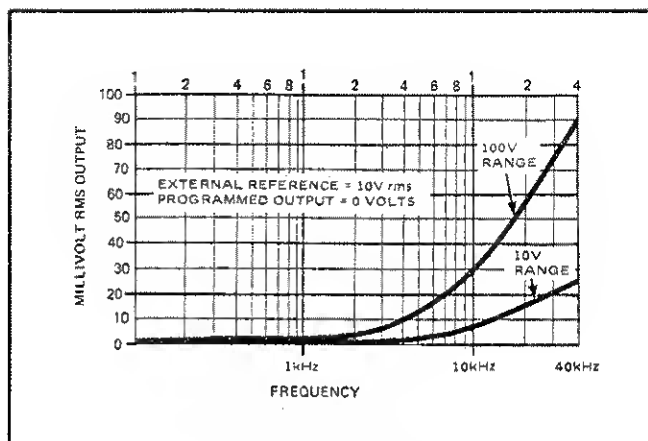
Figure 2-10. AC EXTERNAL REFERENCE FEED-
THROUGH VERSUS FREQUENCY (0V OUTPUT)
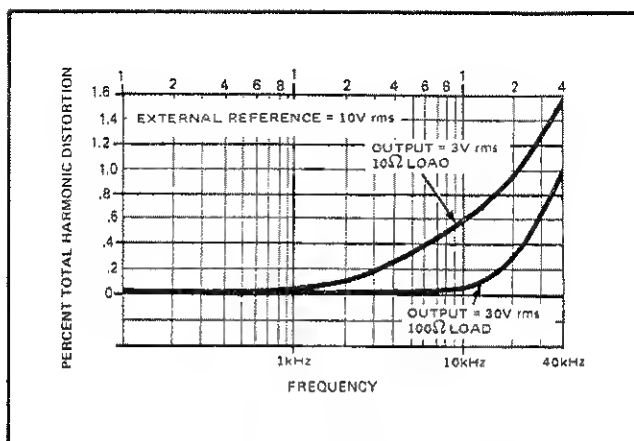
Figure 2-12.   AC EXTERNAL REFERENCE HAR-
MONIC DISTORTION VERSUS FREQUENCY
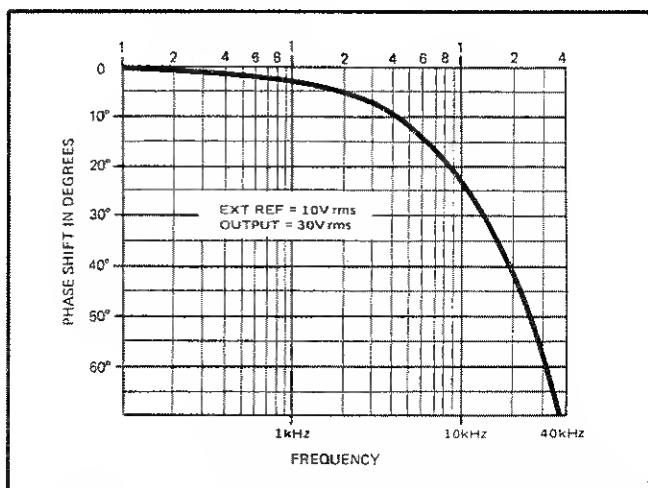
Figure 2-11.   AC EXTERNAL REFERENCE PHASE
SHIFT VERSUS FREQUENCY

Section 3
Theory of Operation

3-1. INTRODUCTION

3-2. This section contains the theory of operation for the Model 4270A. The information is arranged under headings of "FUNDAMENTAL CIRCUIT DESCRIPTIONS, BLOCK DIAGRAM ANALYSIS, and CIRCUIT DESCRIPTIONS." An equivalent circuit of the power source is shown in Figure 3-1. Figure 3-2 is a simplified block diagram.

3-3. FUNDAMENTAL CIRCUIT DESCRIPTION

3-4. The Model 4270A converts a digital program word into a representative dc output voltage. Basically, the circuitry consists of a high gain operational amplifier shown in Figure 3-1. Digital to analog conversion is done using a ladder network driven by a bi-polar reference voltage. The differential amplifier then produces an output voltage (Vo) that is maintained by the current through R_f as determined by the ratio of V_{REF} over $R_0 \left(\dfrac{V_{REF}}{R_0} \right)$

3-5. BLOCK DIAGRAM ANALYSIS

3-6. The following paragraphs describe the major circuit functions of the Model 4270A. A block diagram of the power source, including all options, is shown in Figure 3-2.

3-7. The Isolated Control Logic provides isolation and storage of the digital inputs. A STROBE input is required for any data transfer. The assembly also provides READY/ NOT READY and CURRENT LIMIT FLAG outputs. Internal commands from the A6 LOGIC control polarity, range, magnitude, sample and hold, and current limiting of the output. These commands (except sample and hold) are also applied to the A7 Display where visual status is provided on the front panel.

3-8. All operating voltages as well as the internal reference voltage (V_{REF}) are produced in the A2 Power Supply and the A10 Connector Board. Commands from the A6 Logic determine the polarity of V_{REF} applied to V_{REF} bus line. A +POL command produces a $-V_{REF}$ and a —POL command a $+V_{REF}$. Presence of either or both EXT REF and STDBY commands disable the internal V_{REF}.

3-9. The A4 External Reference (—03 Option) processes the external reference input voltage. The magnitude of this voltage can be from 0 to $\pm 14.5V$ dc or peak ac and have a frequency from dc to 30 kHz. Presence of an EXT REF command disables the previously described internal V_{REF} and applies the output of the A4 External Reference to the V_{REF} bus line. If a STDBY command exists, the external V_{REF} is disabled.

3-10. BCD ladder networks in the A3 Preamplifier and A5 BCD Ladder scale the selected internal or external V_{REF}
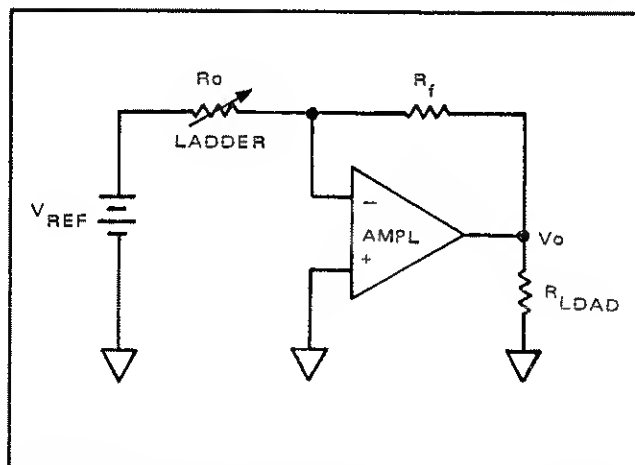
Figure 3-1. POWER SOURCE EQUIVALENT CIRCUIT
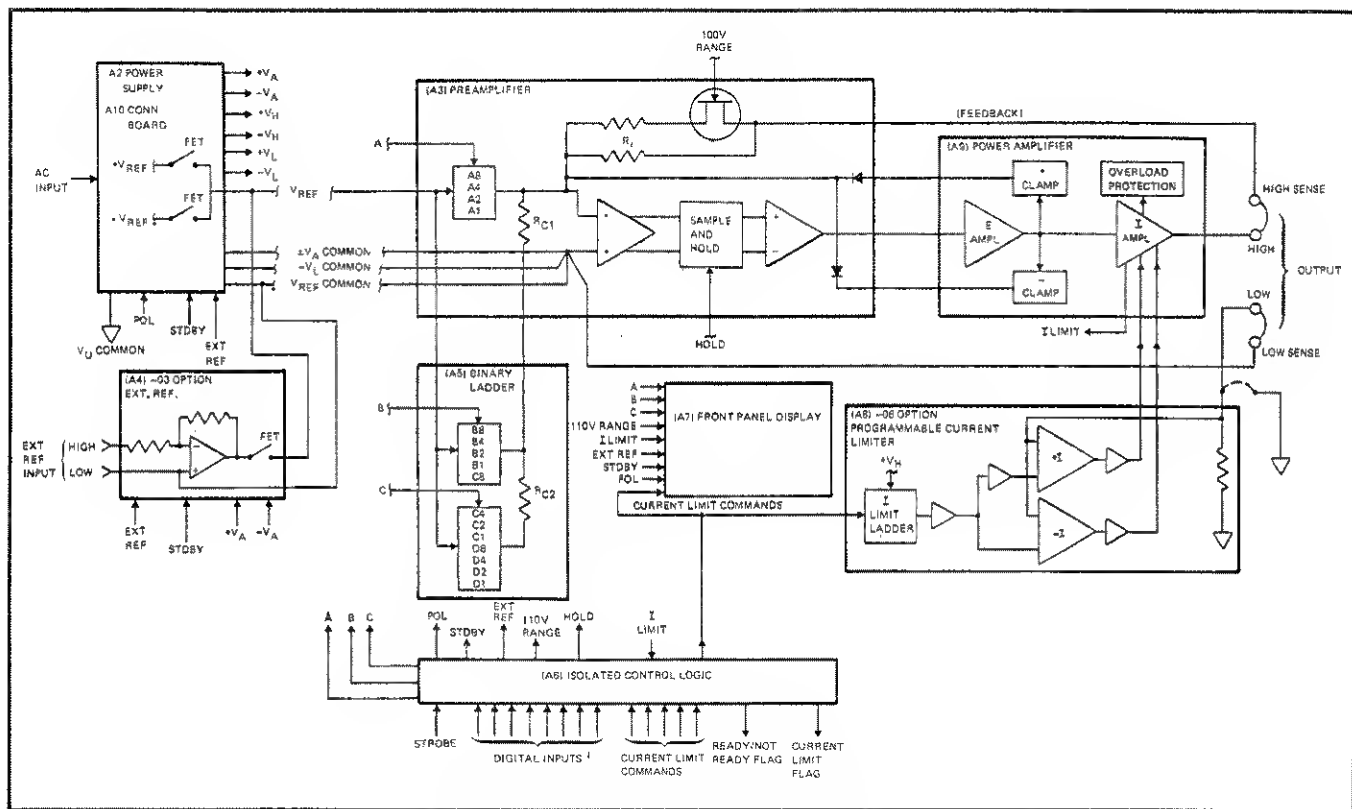
Figure 3-2. MODEL 4270A BLOCK DIAGRAM

to a level determined by the A, B, and C commands. This scaled voltage is then inverted and amplified by voltage and power amplifier in the A3 Preamplifier and A9 Power Amplifier. Current through R_f in the A3 Preamplifier maintains a proportional output voltage dependent upon the value of R_f, ladder, and polarity of V_{REF}. In the 10V range the total parallel value of R_f in combination with an internal V_{REF} establishes an output in millivolts directly proportional to the digital input word. The value of R_f is increased by four times in the 100V range by disconnecting one of the R_f resistors. Subsequently, outputs in the 100V range are four times the digital input word. When the external V_{REF} is selected, the output is proportional to the combined effects of the external reference magnitude and the digital input word. Actual output is determined as follows:

10V Range: Eout = (MPW x 10^{-4}) (EXT REF)

100V Range: Eout = (4MPW x 10^{-4}) (EXT REF)

Where: MPW = Magnitude of digital input word
EXT REF = External reference voltage
(V dc or peak ac):

3-11. Programming changes are prevented from appearing at the output until the entire digital input word is stored. This is provided through the sample and hold circuit in the A3 Preamplifier. Presence of a STROBE input to the A6 Logic produces a HOLD command which activates the sample and hold circuit. The sample and hold disconnects and

stores the last input to the voltage amplifier, thus providing a memory condition for the duration of the HOLD command. The HOLD command has a duration of 15μsec.

3-12. Overload protection circuitry in the A9 Power Amplifier automatically limits the maximum output current to 0.6A. Whenever a current limit occurs, an I LIMIT command is applied to the A6 Logic which then produces a CURRENT LIMIT FLAG output. Current limiting at less than 0.6A is also possible using the A8 Programmable Current Limiter (–06 Option) described later. Clamp circuits in the A9 Power Amplifier limit voltage transients at the output during a current limit condition when the load is disconnected.

3-13. Current limiting at less than 0.6A is provided upon installation of the A8 Programmable Current Limiter (–06 Option). Maximum bipolar output current can be limited to a level between 10 ma and 0.55 ampere in 10 percent steps on two separate reanges. In the event the output current is clamped at that level by action of the A8 Programmable Current Limiter. During periods of current limiting, an I LIMIT command is generated in the A9 Power Amplifier and is applied to the A6 Control Logic and to the A7 Front Panel. The I LIMIT command applied to the A6 Control Logic produces a CURRENT LIMIT FLAG at pin 49 of the Programming Connector. The I LIMIT command applied to the A7 Front Panel illuminates the I LIMIT indicator on the front panel.

3-14. CIRCUIT DESCRIPTIONS

3-15.   The following paragraphs describe the circuitry in the power source. Each description is keyed to a schematic diagram located at the rear of the manual.

3-16. A1 Mother Board and A7 BCD Display (4270A-1011)

3-17.   The A1 Mother Board serves to interconnect the A2 through A9 assemblies. No component circuitry other than connectors and amp pins are contained on this assembly. The A7 BCD Display provides light emitting diode (LED) indicators which display the internal command data and power on state. Internal commands of 0V (true) are inverted by U1 through U5 and turn on the associated LED of Q1 through Q27. Power on is indicated through direct application of $-V_L$ to Q1.

3-18. A2 Power Supply and A10 Connector Board (4270A-1061 and 4270A-1012)

3-19.   All operating voltages, as well as the internal reference voltage upon which the power source accuracy and stability relies, are produced in the A2 and A10 assemblies. Designations and nominal magnitudes of each voltage is given in Table 3-1.

Table 3-1. OPERATING VOLTAGES

DESIGNATION	VOLTAGE (VDC)
$+V_L$	$+5V$
$-V_L$	$-5V$
$\pm V_H$	$\pm 136V$ *
$\pm V_A$	$+23.4V, -25.1V$
V_{REF}	$\pm 10V$
* Approximate (at 115V line voltage, no load)	

3-20.   INPUT POWER

3-21.   Ac line power at J1 is applied to the primary of T1 through POWER switch S2 and the 115/230 switch S1. The primary of T1 consists of two windings which allow operation from either a 115 or 230V ac line. S1 provides a parallel primary winding connection for 115V ac line operation. A series connection is provided for 230V ac line operation. AC power for the blower (M1) is provided from the primary windings of T1. The four secondary windings of T1 supply ac voltages to associated power supplies.

3-22. $+V_L$ SUPPLY

3-23.   The $+V_L$ Supply, composed of CR19 and Q21 through Q24, produces a regulated +5V dc for use by the

A6 Logic and external programming equipment. Diode bridge CR19 rectifies the secondary voltage of T1 and supplies the series regulator of Q21 through Q24 with a dc voltage. C16 filters the voltage applied to the regulator. Q22 functions as a constant current source, supplying base drive to Q23. The resulting +5V output of the regulator is developed across CR23 and R54 which supplies a sample of the output voltage to the base of Q24. The conduction of Q24 will limit the base drive to Q21 and Q23 producing a regulated +5V output. This supply is completely isolated from all other supplies in the instrument and is electrically external of the guard. All other supplies are electrically inside the guard.

3-24. $-V_L$ SUPPLY

3-25.   The $-V_L$ Supply composed of CR14 and Q16 through Q18 produces the regulated $-5V$ dc required to operate the internal logic circuits. Diode bridge CR14 rectifies the secondary voltage of T1 and supplies the series regulator of Q16 through Q18 with a dc voltage. C13 filters the rectified voltage. The base drive for Q18 and Q17 is derived from the $+V_A$ Supply through R44. Reference voltage for the base of Q18 is derived from the $-V_A$ Supply through the divider consisting of R46 and R47. Any variation in the $-5V$ output is then sensed by Q18, which controls the base drive to A17 and thus Q16, producing a regulated $-5V$ dc output.

3-26. $\pm V_A$ SUPPLY

3-27.   The $\pm V_A$ Supply produces the regulated +23.4 and $-25.1V$ dc operating voltages that are used to provide power for most analog circuitry. Diode bridge CR4 rectifies the tapped secondary voltage of T1 and supplies positive and negative voltages for the respective $\pm V_A$ regulators. C7 and C8 filter these rectified voltages.

3-28.   The $+V_A$ regulator consists of Q12, Q13 and U4. Reference voltage for this regulator is derived from A2 in the V_{REF} supply and is applied to the non-inverting input of U4. The inverting input of U4 receives a sample of the output voltage from the divider, R36 and R37. Any variations in the $+V_A$ output are thus sensed by A4, which controls the base drive to Q12, producing a regulated +23.4V dc output. Q13 together with R33 function to limit the maximum output current of this supply to 125 ma. Should the current through R33 exceed 125ma, the voltage across R33 will turn on Q13 which limits the base current to Q12.

3-29.   The $-V_A$ regulator consists of Q14, Q15, and U5. R40 and the $+V_A$ supply establish the reference current for the feedback resistor R41. U5 supplies the base drive required by Q15 to maintain the regulated output of $-25.1V$ dc. Q14 and R39 limit the output current in a similar manner to Q13 and R33 described previously.

3-30. ±V_H SUPPLY

3-31. The ±V_H Supply (on A10) produces unregulated ±136 volts dc operating voltages for the A9 Power Amplifier. Diodes CR1 and through CR4 are connected as two full-wave rectifiers with C2 and C3 acting as filters. Resistors R2 and R3 function as discharge resistor for C2 and C3, respectively. Positive voltage regulation is accomplished by series pass element Q1 which is controlled by driver Q2. Reference voltage for the positive supply is established by Zener diodes CR5 and CR6. Regulation of the negative supply is accomplished by Q3, Q4, CR7, and CR8 which function in a similar manner as the positive supply.

3-32. V_REF SUPPLY

3-33. The V_REF Supply produces an extremely stable ±10V dc reference upon which the accuracy and stability of the power source is based. Circuitry of this supply consists of a stable reference amplifier U2, a differential amplifier U1, a series-pass element Q1, an inverter amplifier U3, and an emitter follower Q4.

3-34. The reference amplifier U2 contains matched zener and transistor elements which produce a time and temperature stabilized reference voltage. The zener element receives a portion of its bias current from the +23.4V supply through R4 and CR1. The amplifier element receives collector current from the same source through R5. Base current for this amplifier is provided through a divider composed of R9, R14, R16, R56 and R59. This divider is connected to the +V_REF sense line. The FET switches, Q2 and Q3, provide separate output and sense connections when a positive V_REF is called. Should any variations occur on the +V_REF sense line, U2 will amplify them with respect to the zener element reference. The change is then applied to one input of U1 which also receives a sample of the +V_REF line from the divider composed of R2 and R3. U1 in turn amplifies the change and alters the conduction of Q1 to maintain a constant +10V output for +V_REF sense. Variable resistor R9 allows adjustment of the sense line input to U2 and subsequently the +V_REF sense level.

3-35. The inverter amplifier composed of U3 and Q4 produces a −V_REF. U3 is connected as an inverting, unity gain, amplifier. Emitter follower Q4 functions as an output buffer. Feedback through R19 and R18 controls the overall gain of both amplifiers. Variable resistor R19 adjust this feedback level and subsequently the resultant −V_REF sense output level. Resistors R6 and R21 compensate for TC factors associated with FET gates in the ladder section driven by V_REF.

3-36. GATE DRIVERS

3-37. The Gate Drivers of Q7 through Q11 control the conduction of the FET switches associated with the V_REF

Supply. When the power source has a positive output programmed, the command at pin 18 is low (−5V), thus turning on Q8, Q11 and switching off FET gates Q2, Q3. With Q8 on, the emitter-base junction of Q9 is reverse biased causing Q9 and Q10 to turn off, thus turning on FET gates Q5, Q6, and Q25. The V_REF output applied to pin D is therefore −10V when a positive output is programmed. Should a negative output be programmed, the command at pin 18 is high (0V), which turns off Q8 and Q11 and switches the FET gates Q2 and Q3 on. With Q8 cut-off, Q9 conducts and turns on Q10, thus switching the FET gates Q5, Q6, and Q25 off. As a result, the voltage at pin D is +10V when a negative output is called. Should the STANDBY or EXT REF mode be programmed, low (−5V) commands exist at pins S or V. These low inputs will turn on Q7 and Q8, thus turning on both Q10 and Q11 and switch all FET gates off. As a result the V_REF supply is completely disconnected from the V_REF output terminals, B and D.

3-38. RELAY DRIVER

3-39. The Relay Driver composed of Q19 and Q20 is used to energize K1 when the power source is turned on. The contacts of K1 then complete the connections to the OUTPUT connector. Whould the power source be shut off for any reason, the connections are broken and the load is not subjected to any unprogrammed voltage.

3-40. A3 Preamplifier (4275A-1051)

3-41. The A3 Preamplifier produces a drive signal proportional to the input programming commands. This drive signal is applied to the A9 Power Amplifier which, in turn, produces the power source output. The circuitry consists of the four most significant bits of the binary ladder and associated switches and drivers, ladder clamps, voltage range switches, high impedance input stage, sample and hold, and output stage.

3-42. BINARY LADDER

3-43. The four most significant bits of the Binary Ladder consist essentially of R26, R27, R29 and R31. Their individual resistance values weigh the division factor necessary to scale V_REF in respective A8, A4, A2, and A1 bit weights. Selection of individual ladder resistors in done through associated ladder switches. Variable resistors R28, R30, and R32 allow precise calibration of the A4, A2, and A1 ladder bits to the A8 bit. The resulting scaled V_REF from these ladder bits is combined with the A5 Binary Ladder input through R25 and applied to the input of Q18A. Feedback from the HIGH SENSE terminal at the output of the power source through resistances selected by the Voltage Range Switches drives the input to Q18 to virtual analog common, in the manner of a high-gain operation amplifier.

3-44. LADDER SWITCHES AND DRIVERS

3-45. The Ladder Switches and Drivers Q1 through Q16, apply V_{REF} or analog common V_A common, to the ladder resistors under control of the A8, A4, A2, and A1 bit commands. Each Ladder Switch-Driver combination functions in the same manner; thus only operation of the A8 bit is described.

3-46. The A8 ladder resistor is connected to V_{REF} or analog common through Q1 and Q2 or Q3, respectively. When an A8 command (0V) exists at terminal 18 of P1, bot Q4 and Q5 will be siwtched off. Q3 is switched off by its resulting $-V_A$ gate voltage and Q1, Q2 are switched on by the resulting V_R, gate voltage. With Q1 and Q2 conducting, V_{REF} is applied to R26. Absence of an A8 command applies $-5V$ to terminal 18 of P1 and switches Q4 and Q5 on. The resulting 0V gate voltage at Q3 switches it on and applies analog common to R26. Q1 and Q2 are switched off by conduction of Q5, which applies $-V_A$ by their gates.

3-47. LADDER CLAMPS

3-48. The Ladder Clamps consisting of CR5, CR6, R47 and R48 limit the summing junction voltage at the input of Q18. Clamp signals at terminals 7, 19, and W of P1 turn on CR5 or CR6 during a current limit condition. This minimizes any output voltage transients at the output of A9 Power Amplifier if the load causing the current-limit condition is suddenly removed.

3-49. VOLTAGE RANGE SWITCHES

3-50. The Voltage Range Switches and Drivers consisting of Q30 through Q34 select the appropriate feedback resistance and frequency compensation for the 10V and 100V range. In the 10V range, a $-5V$ command is present at terminal 14 of P1. This voltage turns off Q34 and Q33, which, in turn, switch on FET gates Q30 through Q32. Conduction of Q31 and Q32 connects R39, R40, R42, and R43 across R36 and R35. The end of this network that connects to pin 4 of P1 ultimately becomes the HIGH SENSE terminal at the output of the power source. The frequency response of the Preamplifier in both voltage ranges is controlled by Q31. In the 32V range, conduction of Q30 by-passes R34 and C2, thus connecting only R33 and C1 to the Preamplifier output. In the 100V range, a 0V command at terminal 14 of P1 turns on Q34 and Q33 which turns off Q30 through Q32. With Q31 and Q32 off, only R35 and R36 are connected to the power source output (HIGH SENSE), thus increasing the total feedback resistance by four. The resulting output voltage is subsequently four times the binary input commands. By connecting the MSB jumpers across R36 and R39 alters the feedback such that only output voltages corresponding to the most significant bit appear at the output. With Q30 off in the 100V range, R33, C1 and R34, C2 are connected in series to establish the desired frequency response.

3-51. HIGH IMPEDANCE INPUT STAGE

3-52. Differential amplifier Q18 amplifies the Binary Ladder output with respect to analog common, V_A common, such that feedback through resistance selected by the Voltage Range Switches produces a virtual analog common at the input of Q18A. Transistor Q19 functions as a constant current source, and Q20 provides temperature compensation. Variable resistor R61 provides adjustment to compensate for the input offset of Q18. Jumper selection of R57 through R59 and R62 provides coarse offset adjutment. Selection of R_P and R_N in the drain circuit of Q18 is done to provide a low temperature coefficient of input offset voltage. Diodes CR7 through CR12 limit the maximum voltage swing applied to the following stage.

3-53. SAMPLE AND HOLD

3-54. The Sample and Hold circuitry consists of MOSFET gates Q21, Q22, driver Q23, and capacitors C10 and C11. These capacitors provide memory during programming changes. Normally, a HOLD command (0V) is present at terminal P of P1 and Q23 is conducting. This condition turns on Q21 and Q22 and the output of Q18 is amplified by Q24, Q25. During programming changes, however, presence of a HOLD command ($-5V$) at terminal P of P1 turns off Q23 and Q21, Q22. Capacitors C10 and C11, which are connected to the inputs of Q24, then hold a sample of the last input from Q18 and hold the output voltage relatively constant for the duration of the HOLD command. The HOLD period is short enough and the circuit constants are chosen so that negligible output voltage change occurs. A secondary HOLD circuit composed of U1 and Q35 through Q37 provides a clamp to analog ground at the input of Q18 during the HOLD command. Presence of a HOLD command ($-5V$) presets J-K flip-flop U1 to provide a low Q output, which turns on Q37. Q36 is switched on by the resulting $-V_L$ common base signal and turns on Q35, which applies analog common to the base of Q18.

3-55. Transistor Q26 functions as high impedance constant current source for Q25B. Q27 and Q28 amplify the output of Q25B and furnish a drive signal to Q29.

3-56. OUTPUT STAGE

3-57. Emitter follower Q29 provides a low impedance output signal at terminal 5 of P1. This signal is applied to the A9 Power Amplifier which then produces the power source output.

3-58. A4 External Reference (4210A-1041)

3-59. The A4 External Reference is installed as the -03 Option. It receives and processes an external reference input having a frequency of dc to 30 kHz and a level from 0 to $\pm14.5V$ dc or peak ac. The circuitry consists of three dif-

ferential amplifiers and an emitter follower which form
an operational amplifier. FET gates Q9 and Q10 controlled
by drivers Q11 and Q12 apply the amplifier output and sense
line to the V_{REF} line in the A3 Preamplifier.

3-60. DIFFERENTIAL AMPLIFIER

3-61.   The differential Amplifier consists of three in-
dividual amplifiers: Q1 through Q8 and the emitter follower
of Q13. The external reference input is applied through R1
and C9 to tone input of the differential FET, Q1. This stage
amplifies the input in respect to V_{REF} common and provides
a differential input to Q5. Feedback through R16 and R17
maintains the input of Q1 at virtual V_{REF} common. Adjust-
ment of R17 controls the overall gain and subsequently the
output V_{REF} high at terminal 4. Variable resistor R6
allows zero offset adjustment of the output, V_{REF} high.
Jumper selection of R5 and R8 through R10 provides coarse
adjustment of offset. Selection of R_N and R_P in the drain
circuit of Q1 is done to provide a low temperature coefficient
for the offset voltage. A constant current source for Q1 is
provided by Q2, while TC compensation of the current source
is provided by Q3. The differential Darlington composed of
Q4 and Q5 amplifies the output of Q1 and furnishes a single-
ended drive signal to Q7. This drive signal is developed across
Q6 which functions as a high impedance, constant current
source for Q4B. The final quasi-differential amplifier Q7
and Q8 supplies a drive signal to the emitter-follower output
stage of Q13. This stage provides a low impedance output
to drive the V_{REF} high line. Q14 functions as a high imped-
ance current source for Q13. Diodes CR1 and CR2 provide
connection to the feedback line when Q9 and Q10 are turned
off.

3-62. FET GATES

3-63.   The application of the external reference to the in-
ternal stet lines is controlled by Q9 and Q10. Q9 connects
the feedback line to V_{REF} sense, and Q10 connects the ex-
ternal reference to the internal V_{REF} high line. Drivers Q11
and Q12 control the on/off condition of Q9 and Q10 in
conjunction with the EXT REF and STANDBY commands at
terminals 13 and M.

3-64.   When an EXT REF command (0V) exists at termin-
al 13, Q11 is turned off, and $-V_A$ is applied to both the
emitter and base of Q12. This condition turns off Q12
and switches FET gates Q9 and Q10 on, thus applying the
external reference to the internal V_{REF} line. The same con-
dition occurs when a STANDBY command (0V) exists at
terminal M. Diodes CR3 and CR4 provide isolation between
the input command lines.

3-65.   Should a STANDBY or EXT REF command ($-5V$)
exists, Q11 will be switched on and turn on Q12. Conduc-
tion of Q12 applies $-V_A$ to the gates of Q9 and Q10 which
turns them off. This condition then disconnects the external
reference from the internal V_{REF} lines.

3-66.   A5 BCD Ladder (4210A-1031)

3-67.   The A5 BCD Ladder contains a buffer amplifier for
V_{REF} and the three lower decade segments of a ladder net-
work. The buffer amplifier produces a V_R signal from
V_{REF} to prevent loading of V_{REF} by ladder switching cur-
rents. The ladder decades are voltage dividers weighted in
fifteenths for control by digital words from 1 to 15
$(8 + 4 + 2 + 1)$. The relative position of each decade with
respect to the ladder output determines the significance of
each decade's contribution to the total ladder network out-
put.

3-68.   BUFFER AMPLIFIER

3-69.   The Buffer Amplifier composed of Q1 through Q3
is a unity gain amplifier connected through CR1 to function
as a voltage follower. This circuit produces a V_R Signal that
is applied to the ladder driver circuits. Output impedance is
sufficiently low from dc to 100 kHz to prevent loading by
ladder switching currents.

3-70.   LADDERS

3-71.   The three lower decade ladders consists of R1
through R18. Each decade of the ladder is formed essentially
by four resistors which in combination weigh the division
factor of each decade in fifteenths. A simplified diagram of
a typical decade ladder is shown in Figure 3-3.

Figure 3-3. LADDER DECADE (SIMPLIFIED)

3-72. DRIVERS

3-73. Each ladder resistor is connected to V_{REF} common using a driver such as the one shown in Figure 3-4. When the bit command is high (0V), QA and QC are both turned off, which applies $-V_A$ to the gate of QB and V_R, to the gate of QD. This condition switches QD on and QB off, thus applying V_{REF} through QD to the ladder resistor R_N. Absense of a bit command will apply a low (−5V) to the base of QA which causes it to conduct. The resulting 0V collector signal switches on gate QB and the driver QC. Conduction of QC applies $-V_A$ to the gate of QD, turning lt off. As a result, V_{REF} common is applied through QB to the ladder resistor R_N.

Figure 3-4. LADDER DRIVER (SIMPLIFIED)

3-74. A6 Isolated Control Logic (4275A-1021)

3-75. The A6 Isolated Control Logic assembly receives and processes all input and output data at the Programming Connector, J1. A logic diagram in simplified form is shown in Figure 3-5.

3-76. PRESET GENERATORS

3-77. Two Preset Generators are used in the Isolated Control Logic. Their purpose is to preset all counters, flip-flops, and registers to their proper state when the supply is first turned on. This is to insure that the output of the power source is programmed to its minimum value, and that all logic is in the proper state to accept input data and process it properly upon command. One Preset Generator is used to preset the input programming circuitry and is composed of Q8 and Q5. When input power is applied the $+V_L$ supply rises to its regulated level of +5 volts. At this point C5 has not been charged, and Q8 and Q5 are turned off, leaving the preset line high. C5, driven by the current from the +5V supply begins to charge C5 at a linear rate. The voltage divider composed of R9 and R10 provides a +4V reference to the gate of a Programmable Unijunction Transistor, Q8. When the charge on C5 reaches approximately +4.5V, the gate of anode Q8 is forward biased causing it to turn on

and latch. C5 now begins to rapidly discharge through Q8 and R11. The voltage developed across R11 is sufficient to turn on Q5, which causes the preset line to go low, thereby presetting all input programming circuitry. When the discharge of C5 is almost complete, the voltage drop across R11 can no longer supply base drive to Q5; it therefore turns off, allowing the preset line to return to its high state.

3-78. The second Preset Generator is used to preset the shift registers in the isolated portion of the logic circuitry. It is composed of Q16 and Q15 and is less complex than the preset generator previously described. When input power is applied, the $-V_L$ supply rises to its regulated level of−5V. At this time Q16 is not conducting, C33 is not charged, and the output of U15 is −1V. C33 now begins to charge at an exponential rate through R57. R54 and R55 form a voltage divider which provides a −1V reference to the gate of a Programmable Unijunction Transistor, Q16. When the charge on C33 reaches approximately −0.5V, the gate to anode of Q16 is forward biased causing it to turn on and latch. C33 now begins to rapidly discharge through Q16 and R58. The voltage developed across R58 drives the input of Q15 toward 0V, causing its output to drive close to −5V and clear shift registers U20, U21 and U22. As the discharge of C33 is almost complete, the voltage drop across R58 approaches zero volts allowing the input of Q15 to return to a −5V level. The output of Q15 then returns to 0V, completing the preset pulse. Q16, however, remains latched because of the small holding current supplied through R57.

3-79. DATA TRANSFER SEQUENCE

3-80. The parallel program data (output voltage magnitude, sign, output voltage range, current limit magnitude and external reference function) is applied to the inputs of a series of multiplexing circuits as shown in Figure 3-5. When the data is settled at the multiplexer inputs, the program source generates a strobe signal having a duration of nanoseconds or longer. The strobe pulse is fed via an integrator to the trigger input of a delay one-shot. The integrator provides noise immunity, and triggers the delay one-shot when it receives a pulse having a width of 800 nanoseconds or greater. The delay one-shot produces an 800 nanosecond pulse, the leading edge of which triggers the hold one-shot (via T5) to produce an eight or 16 microsecond pulse to the hold input of the power source. The width of the hold one-shot output pulse depends upon the particular power source model. That is, the 4210A and 4216A require an eight microsecond hold pulse, while the remaining models require a 16 microsecond hold pulse. In either case, the hold pulse is used within the A3 assembly to hold the output voltage magnitude constant while programming is underway.

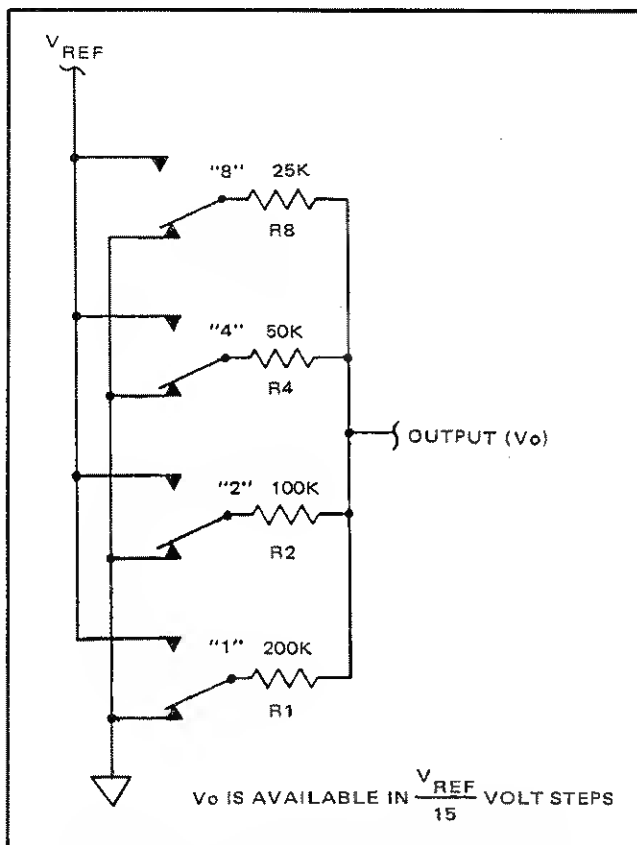3-81. The trailing edge of the delay one-shot output triggers the not ready one-shot and sets the start/flip-flop. The not ready one-shot generates a 100 microsecond pulse which

becomes the not ready flag output to the program source. The not ready flag indicates that the 4200-09 is busy and not available to accept program data or strobe signals from the program source. When the start/stop flip-flop becomes set, the Q output provides a start signal (voltage level) to the start/stop input of a 10 MHz clock. The Q output of the start/stop flip-flop is also fed to an input of gate U12-8 to gate the clock output pulses to various portions of the control logic to transfer the program data across the guard. Concurrently, the Q output of the start/stop flip-flop inhibits gate U14-3 to prevent clock pulses from reaching the primary winding of T4. (This function is described in later paragraphs.)

3-82.   The 10 MHz clock pulses gated by U12-8 are fed to the input of a ÷ 16 (four-bit binary) counter. At the time of the sixteenth clock pulse, the counter reaches full count and generates a carry pulse to the reset input of the start/stop flip-flop (and also to the reset input of the ocmplement flip-flop described later). As the counter advances through its 16 states, the four binary weighted (1, 2, 4 and 8) outputs address the multiplexer channels and move the bits of data applied to the parallel inputs over to the multiplexer output. For example, the first clock pulse to the counter advances it from the zero state to the first state in which the "1" output is true and the "2", "4" and "8" outputs are false. As a result, the second channel of U1 and U4 is addressed, and the second bit of data appears at the multiplexer outputs. As the counter advances the subsequent inputs of U1 and U4 appear at the multiplexer outputs, until the count of eight is reached. At this point, the "8" output becomes true to inhibit U1 and enable U2. The eight inputs of U2 are sequentially addressed in the same manner as U1 and the program data appears in serial format at the U2 output, and is commonly connected with the U1 output. During the 16-state cycle of the counter, U1 and U2 are each cycled once, while U4 is cycled through its eight addresses twice. This is of no consequence since input data has not changed during the generation of the 16 clock pulses.

3-83.   The 16 clock pulses are fed to inputs of gates U13-3 and U13-5 to gate the serial program data appearing at the multiplexer outputs to the primaries of T1 and T3. The clock pulses are also fed directly to the primary of T2. The transformers couple the signals across the guard. On the inside of the guard, the clock pulses are applied to three eight-bit shift registers causing the registers to load the serial program data. Shift registers U20 load the 16 bits of output magnitude data while U22 loads (twice) up to eight bits of control data. The parallel outputs of U20 and U21 are applied directly to the ladder network assembly (A5), while the parallel outputs of U22 are applied to a series of latch circuits. To load the control data into the latch circuits, the first of the 16 clock pulses triggers a latch-timing one-shot which has a period of two microseconds. This one-shot is not re-triggerable by the subsequent clock pulses, and the trailing edge of the output pulse occurs after the clock pulses

and serial transfer of data into the shift registers is complete. The trailing edge triggers the latch load one-shot to parallel load the eight bits of control data from the shift register into the latch circuits for application to the control circuits within the power source.

NOTE!

Complementing magnitude data occurs only in binary-type power sources.

3-84.   COMPLEMENTING BINARY DATA

3-85.   Binary-type power sources require that negative value of magnitude data be two's complemented since binary program sources usually indicate polarity by means of a single bit and supply two's complemented magnitude data for negative outputs. The binary-type power sources require non-complemented binary data plus a polarity bit. As a result, negative binary magnitude data, consisting of complemented data, must be re-complemented to satisfy the requirements of the power source. When the binary program source indicates negative sign, gate U9-8 is enabled to pass the output of the complementing logic. The complementing logic receives the serial output of U1 and U2, complements it, and passes it across the guard via T1.

3-86.   Operation of the two's complementing logic (U9 and U10) is such that the first bit of serial data (multiplex address zero) is present at the output of multiplexer, U1, before the ÷ 16 counter and complement flip-flop (U10) receives the first of 16 clock pulses. At this time, the ÷ 16 counter is in its zero state to address channel zero of U1, and the complementing flip-flop is still reset (as a result of the carry pulse generated by the ÷ 16 counter at the end of the previous data transfer sequence). With the complement flip-flop reset, the complement logic is not enabled and no inversion of serial data takes place. This condition permits the first binary magnitude data to be transferred without being complemented. However, after the first clock pulse, the complement flip-flop may be allowed to go set (to enable the complement logic) depending upon the state of the J input, which is derived from the serial data. As a result, the complement flip-flop goes set at the time of the first true bit of serial data is enable the inverting logic and complement the remaining bits of serial data. After the 16th bit of data, the complementing flip-flop is reset by the carry output of the ÷ 16 counter.

3-87.   STANDBY OPERATION

3-88.   The power source can be commanded to standby or operate mode at any time by the program source. As shown in Figure 3-5, the standby command (dc) is gated to the start input of the 10 MHz clock. The clock is turned on and generates pulses as long as the standby signal is present. The start/stop flip-flop remains reset from the last transfer sequence to enable gate U14-3 and pass the clock pulses

via T4 to a half-wave rectifier on the inside of the guard. The dc output of the rectifier becomes the standby signal for control of the power source. During standby operation, data transfer does not take place due to the start/stop flip-flop being reset and gate U12-8 being inhibited.

3-89. CURRENT LIMIT FLAG

3-90. The current limit flag produced by the A9 Power Amplifier whenever the power source is in the current limit mode, is used to enable a 1MHz oscillator (U19) which produces pulses at a 1MHz rate. The pulses are fed via T6 to the trigger input of a re-triggerable one-shot having a period of 1.1 microseconds. As long as the 1MHz pulses occur, the output of the re-triggerable one-shot is held at dc level which becomes the current limit flag to the program source.

3-91. A8 Programmable Current Limiter (4270A-1081)

3-92. The A8 Programmable Current Limiter is installed as the –06 Option. It compares the voltage from a ladder network to an input voltage proportional to the output current. When the output current exceeds the ladder network reference, a clamp signal is produced that is used to limit the output current of the A9 Power Amplifier. The A8 Programmable Current Limiter contains the following circuitry: an 8-4-2-1 to 4-4-2-1 binary code converter, FET drivers, a ladder voltage reference, ladder switches and a ladder, a programmable reference and programmer reference inverter, and two current limit comparators — one positive and the other negative. Auxiliary circuits are a ground isolator and two power supplies, one 15 volts and the other –16 volts. A two-ohm current sampling resistor is tied to the input of the two current limit comparators.

3-93. 8-4-2-1 to 4-4-2-1 CONVERTER

3-94. This logic converter consists of two, digital integrated circuit, hex-inverters U1A through U1F and U2A through U2F. They convert the input 8-4-2-1 code to 4-4-2-1 code, and in the absence of any programmed inputs, program the ladder to the lowest current limit, 10 milliamps. This is the quiescent state of the limiter in which ladder swtich Q4 and the current range switch Q26 are turned on, placing operational amplifier U4 in low range. This ensures that the Model 4275A current limits at the lowest current, limits at the lowest current, 10 milliamps, as a safety feature. In the event a programmed input for 80 milliamps is applied to the converter, the logic input is applied to two circuits, one directly to the base of FET Driver Q13 and the other indirectly through two inverters U2F and U1A to the base of FET Driver Q10. These two drivers turn on ladder switches Q9 and Q12 and two code 4 ladder resistors, thereby applying an equivalent 8 to the Programmable Reference amplifier and establishing a current limit of 80 milliamps.

3-95. FET DRIVERS

3-96. The ladder FET DRIVERS consist of PNP-NPN Transistor pairs Q3-Q5, Q7-Q8, Q13-Q14, and Q10-Q11. The emitters of these pairs as well as the current range FET drivers Q15-Q16, are returned to V_L common through a ground isolator network is described later. The purpose of the drivers is to increase the voltage output of the converters to a level required by the FET switches.

3-97. LADDER VOLTAGE REFERENCE

3-98. The Ladder Voltage Reference consists of a temperature compensated, 6.3 volt zener diode CR7 and produces a stable reference voltage that is reduced to 0.1 volt at TP3 by resistors R4, R6, and R59. This voltage reference is supplied by the regulated +15 volts power supply (TP2) consisting of 16 volt zener CR1, transistor Q28, and associated components.

3-99. LADDER SWITCHES AND LADDER

3-100. The Ladder Switches and Ladder, respectively, consist of FET switches Q4, Q6, Q12, and Q9 and resistors R52, R55, R54, and R15. The ladder resistors are weighted in a ratio of 1, 2, 4, and 4. The ladder operation is best explained in conjunction with the Programmable Reference. (See paragraph 3-121.)

3-101. PROGRAMMABLE REFERENCE AMPLIFIER

3-102. Programmable Reference Amplifier U4 is monolithic IC operational amplifier. Assuming current range switch Q26 is on, then U4 output voltage varies between –0.01 volt and –0.11 volt as the ladder resistors are switched into the circuit by the FET switches. That is, with only Q4 on, the output voltage is –0.01 volt. With Q4, Q6, Q12, and Q9 on, the output voltage is –0.11 volt. The range is set by R31 in parallel with R30 and is the 10 ma to 110 ma current range. With Q26 turned off, the range is determined by R30 alone. This is the 100 ma to 1.1 ampere range (Current Limit x 10 command) in which the ladder resistors produce an output from U4 of –0.1 volt to 1.0 volt. Amplifier U3, also a monolithic integrated circuit, together with resistors R24 and R25, forms a unity gain, inverting amplifier. The output of U3 is the same magnitude as that of U4, but of opposite polarity.

3-103. POSITIVE AND NEGATIVE 1 LIMIT COMPARATORS

3-104. Since the comparators function in the same manner, except for polarities, only the positive comparator is described. The output current from the Model 4275A flows through a one-ohm resistor, R51. A *positive* output current through this resistor produces a positive voltage that is compared to the output of U3 by action of transistor Q17.

When the positive output of U3 is greater than the positive voltage developed across R51, Q17B is on and Q17A is off, as are Q18, Q19, and Q17. This corresponds to the Model 4275A output current being less than the programmed 1-limit. When the positive output of U3 is less than the positive voltage developed across R51, Q17A, Q18, Q19, and Q27 are all on and conducting. The greater the difference between the R51 and U3 voltages, the greater these transistors conduct. The collector of Q27 connects, by way of pin 2 of P1, to the base of Q31 on the A9 Power Amplifier. When the Q27 collector conducts, it shunts base current drive away from Q31, limiting the 4275A output current to the programmed level. Transistors Q18 and Q27 are common-base stages used as voltage translators: Q18 from the —10 volts level of Q17A to Q19 which is referred to V_H (about —100 volts), and Q27 from Q19 are essentially the OUTPUT HIGH terminal voltage. Transistor Q19 provides current gain and Q20 is used as a temperature compensating diode for Q19. Capacitor C4 and resistor R40 are the primary frequency response determining components. Transistor Q25A and Q25B compares a negative reference voltage to negative voltages produced across resistor R51 by the output current in a manner similar to Q17A and Q17B. Transistors Q24, Q21, Q23, and Q22 correspond in function to Q18 through Q20 and Q27, respectively.

3-105. GROUND ISOLATOR

3-106. The Ground Isolator circuit, composed of transistors Q1 and Q2 isolate the ground currents flowing in V_H COMMON from those in V_L COMMON. The input logic lines driving the first transistor of each pair of FET Drivers (the emitters of the drivers) are referenced to V_L COMMON indirectly through transistors Q1 and Q2. Thus, the only current through the point of commonality of $V_L - V_A - V_H$ is base current of Q1 and this has but a negligible effect in the OUTPUT LOW sense line.

3-107. MINUS 16 VOLTS POWER SUPPLY

3-108. Diode CR2, a 16 volt zener, produces —16 volts at test point 4. This voltage is used in the Ground Isolator, the FET Drivers, and U3 and U4.

3-109. A9 Power Amplifier (4270A-1071)

3-110. The A9 Power Amplifier produces the final output voltage and current of the power source. It also provides both source and sink current limit protection of the bipolar output. The circuitry consists of an input amplifier, driver, clamp circuitry, current sources, output stage, and current limit detector.

3-111. INPUT AMPLIFIER

3-112. The Input Amplifier composed of Q9 through Q11 and Q20 through Q25 amplifies the input appearing at ter-

minal D of P1. The resulting voltage at the emitter of Q11 corresponds closely to the programmed output voltage. A closed-loop dc gain of five is established by feedback through R62 and R21. Overall frequency response is controlled to 6 db per octave by C6. Amplifiers Q22 and Q23 link V_H common to the A3 Preamplifier common (V_{REF} common) such that current flow between these two points is minimized. Q20 and Q21 provide current with respect to the common established by Q23, Q22 emitters. Emitter follower Q9 and amplifier Q10 provide voltage gain and a drive signal to the output emitter follower Q11. Overall frequency response to this point is controlled with feedback through C6. The resulting emitter voltage of Q11 is close to the final output voltage of the power source. Transistors Q24 and Q25 function as current sources of Q10 and Q11, respectively.

3-113. DRIVER

3-114. The Driver consisting of Q12 and Q26, form complementary current amplifiers. These amplifiers receive a bipolar drive voltage from Q11 and together with the CURRENT SOURCES produce respective drive currents for the output stage. The voltage drops across Q13, CR33, Q17 and CR27 together with variable resistor R51 set the bias current required for the output transistors Q32, Q33, Q41 and Q42. Q13 collector current is turned off when a (+) current limit condition exists and Q17 is affected similarly for a (—) current limit. These collectors drive the CURRENT LIMIT DETECTOR.

3-115. CLAMP CIRCUITRY

3-116. Voltage transients that would occur during a current limit and abrupt load removal are limited by the Clamp Circuitry. Two circuits titled + Clamp and — Clamp limit the bipolar transients. The + Clamp consists of Q1 through Q4. Transistors Q5 through Q8 form the — Clamp. Since operation of each circuit is the same, except for polarity, only the + Clamp is described.

3-117. The + Clamp monitors the voltage between the emitter of Q11 and that on the anode of CR33. Normally, Q1 and Q2 are cut-off and Q3 is conducting; however, when a current limit occurs, the anode voltage of CR33 decreases through action of either the built-in current limiter (overload protection) or the A8 Programmable Current Limiter (optional) and subsequently turns off Q3. The voltage at the emitter of Q11, will increase toward +V_H during current limiting and this turns on Q2. Conduction of Q2 turns on Q1 and produces a clamp signal at terminal 6 of P1. This clamp signal then limits the summing junction voltage in the A3 Preamplifier and causes the emitter voltage of Q11 to be clamped to a voltage slightly above that of the base drive to the Output Stage. Transistor Q4 functions as a current source for Q2 and Q3. Frequency and phase characteristics of the + Clamp circuitry is determined by C1, C2, C26 and R65.

3-118. CURRENT SOURCES

3-119. Constant current for the Output Stage is provided by the Positive and Negative Constant Current Sources. Transistor Q30 forms the Positive Constant Current Source. The Negative Constant Current Source consists of Q38. The positive and negative constant current sources produce a constant reference current for the bases of Q31 and Q37, respectively.

3-120. OUTPUT STAGE

3-121. The Output Stage consisting of Q31 through Q35 and Q37 through Q42 produces the power source output. It also provides both sourcing and sinking current limit protection.

3-122. Transistors Q31 through Q33 and Q37, Q41, Q42, form a complementary, emitter follower stage. Q31 through Q33 produce the positive output and Q37, Q41, Q42 the negative. Total output current flows through R43, R44 (positive) and R47, R48 (negative).

3-123. Both sourcing and sinking current limit protection is provided for each section of the output amplifier. Q34 protects the positive output section and Q35 the negative. Maximum output current (sourcing) is limited to 1.2A. Sinking current is limited at a lesser value depending on the programmed output voltage. Since operation of each current limiter is the same, only the positive output section protected by Q34 is described.

3-124. Output current passes through R43. This current produces a bias voltage for A34. When the output current (sourcing) exceeds 0.6A, the resulting potential turns on Q34. Conduction of Q34 via CR34 shunts any further base drive current to Q31, thus limiting the maximum sourcing

output current at 0.6A. In the sinking mode, output current will pass through R43 to the output as above, but the output voltage polarity is zero or negative by definition. Under this condition, negative voltage more than −0.6V at the output will turn on CR25 which supplies base current for Q34 through R41 from common and adds to that supplied from the voltage drop across R43. Therefore, the base current is dependent on both sinking voltage magnitude and output current. Current limiting in milliamperes is equal to $500 - 4.5E_{out}$.

3-125. When the A8 Programmable Current Limiter −06 Option is installed, $\pm$I LIMIT inputs are applied to terminals 2 and U of P1. These inputs clamp the maximum base drive to both sections of the Output Stage in a similar manner to Q34, thus limiting the maximum output current at a level determined by the input limit commands.

3-126. CURRENT LIMIT DETECTOR

3-127. The Current Limit Detector produces an I LIMIT (0V) command at terminal 14 of P1 whenever a source of sink limit condition exists. Circuitry consists of Q14 through Q16, Q18 and Q19. Positive output section limiting is detected by Q14. Limiting in the negative output section is detected by Q18. Transistors Q15, Q16 and Q19 are drivers.

3-128. Under normal operating conditions Q14 and Q18 are turned on by conduction of Q13 and Q17 in the Driver. Transistors Q15 and Q19 are switched off by conduction of Q14 and Q18, thus turning Q16 on and producing an I LIMIT (−5V) command at terminal 14 of P1. Should a current limit occur in the positive or negative section of the Output Stage, the associated Q13 or Q17 in the Driver will be turned off. This turns off Q14, Q15 or Q18, Q19, thus turning Q16 off and producing an I LIMIT (0V) command at terminal 14 of P1.

Section 4
Maintenance

4-1. INTRODUCTION

4-2. This section contains servicing information for the instrument. Table 4-1 lists the recommended test equipment. If the recommended equipment is unavailable, use test equipment of equivalent or superior specifications.

4-3. SERVICING INFORMATION

4-4. All products manufactured by the John Fluke Mfg. Co., Inc. are warranted for a period of one year. Complete warranty information is located in the WARRANTY at the front of the manual

4-5. Factory authorized calibration and services is available at various world-wide locations. A list of authorized service centers is located at the front of the manual. If requested, an estimate will be provided before repair work is done on an instrument that is beyond the warranty period.

4-6. GENERAL MAINTENANCE

4-7. Cleaning

4-8. This instrument should be cleaned periodically to remove dust, grease, or other contaminates. The exterior of the instrument can be cleaned with a clean cloth moistened with anhydrous ethyl alcohol or Freon T.F. Degreaser (MS 180) available from the Miller Stephensen Chemical Co., Inc. If neither cleaning agent is readily available, soap and water applied sparingly to a clean cloth is usable. Interior sections of the instrument are cleaned using clean, dry air at low pressure.

4-9. Air Filter Cleaning

4-10. A removeable air filter is attached to the rear panel and against the blower by a covering bracket that is held in place by four screws. This air filter should be removed and cleaned frequently to remove accumulations of dust and grease. The air filter is removed by unscrewing the four covering bracket screws, removing the bracket, and separating the bracket and filter. Cleaning is done by rinsing the filter in hot detergent solution frequntly for best results. After the filter is dry, install it as indicated by the air flow arrow scribed on the frame of the filter. Secure the filter bracket to the rear panel with four screws.

4-11. Fuse Replacement

NOTE

Turn off power switch and disconnect instrument from power supply (line power) before replacing fuse.

4-12. The power fuse is located on the rear panel of the instrument. If replacement is necessary, use the following rated fuses:

AC LINE VOLTAGE		AC LINE VOLTAGE	
100	2A, AGC	200	1A, AGC
115	Slo Blo	230	Slo Blo
125		250	

4-13. MAINTENANCE ACCESS

4-14.   Access to the interior of the instrument shown in Figure 4-1 is as follows:

a.   Turn off the power switch and disconnect the power cord from line power.

b.   Remove the top dust cover and the underlying guard cover to gain access to all of the calibration adjustments, test points, and most of the PCB assemblies. Note that most of the calibration adjustments are labeled on the guard cover.

c.   Removal of the A10 PCB requires prior removal of the A2 PCB, the bottom dust cover, and the A9 Power Amplifier PCB and heat sink. However, if A10 PCB removal is not desired, proceed to step k.; otherwise continue as follows. The A9 heat sink is secured to the bottom guard tray by two screws accessible from the upper surface of the guard tray. The A9 PCB assembly and attached heat sink are removed from the A1 PCB as a unit following disconnection of the A9S1 thermostatic switch cable A9W1 from the A10 PCB at A10P2. Refer to Interconnect Diagram 4270A/4275A-1000.

d.   Following removal of the A9 PCB, the machine screws securing the two longitudinal cross braces to the guard tray must be removed. Next, four large machine screws securing the lateral cross bracket to the front panel at the rear of the A1 PCB (two high and two low) must be removed.

e.   The lateral and longitudinal cross braces with attaching A10 PCB, A10 heat sink, and 1A1T1 power transformer, may be displaced obliquely internal of the instrument following removal of two machine screws through the rear panel of the instrument and disconnection of the A10A1 connector PCB from the A2 PCB receptacle J1. In addition, the blower power cable A10W3 must be either unsoldered from the A10 PCB or disconnected from the blower motor at the blower itself. The latter requires removal of the blower filter bracket, filter, and fan as outlined in paragraph 4-10. The blower cable is then removed, within a protective grommet, from a rear panel slot to free it from the instrument chassis.

f.   This step is readily accomplished providing that the A2 PCB assembly is previously removed from the instrument, since greater freedom of movement is allowed. Remove the overall assemblage described in previous step by lifting vertically out of the instrument while simultaneously rotating the

assemblage obliquely to clear the rear panel overhang. Exercise care in withdrawing the flatwire cable A10W1 and connector PCB A10A1 with the assemblage to prevent damage.

g.   With the assemblage removed from the instrument and placed on a level, clean surface and the power transformer being farthest away, remove the two machine screws securing the shorter longitudinal brace to the lateral cross brace.

h.   Remove the six machine screws from the longer longitudinal brace. These screws secure the A10 PCB to the brace. Hold the power transformer steady and withdraw the A10 PCB with attaching parts from the transformer cable receptacle 1A1J1.

i.   Separation of the short longitudinal brace from the A10 heat sink and filter capacitors is accomplished by releasing the heat sink alignment clip screw and the two screws in the capacitor support brackets, these latter two being hidden beneath the heat sink. The brace may then be separated from the A10 components by a firm, even pulling force.

NOTE

PCB's can be mounted on an accessory extender PCB assembly for servicing. See Section 6 for use of the extender and associated extender cable.

j.   Removal of the A2 through A6, A8 and A9 PCB's is done by pulling rearward with a firm rocking motion on each PCB. However, those PCB's with rear panel brackets (A2 and A6) must be freed of attaching rear panel screws.

k.   The A9 PCB is secured to the bottom guard tray through the A9 heat sink. Hence, A9 PCB removal requires prior removal of heat sink attaching screws accessible from the upper surface of the bottom guard. The A9 PCB and heat sink are withdrawn from the instrument as a unit following disconnection of the A9S1 thermostatic switch cable from the A10 PCB at A10P2. Refer to Interconnect Diagram 4270A/4275A-1000.

l.   In the event the A2 PCB is removed from the A1 PCB and reconnected via the extender PCB assembly, as in servicing or troubleshooting, an accessory cable extender assembly must be used to tie the A2 and A10 PCB's together electrically. The recommended installation is depicted in Section 6 of the manual.

m. Access to the A1 and A7 PCB pair is possible after removal of the front panel. To remove the front panel, remove the bottom dust cover and then remove the rack mountings, if installed, from the front corners. If no rack mountings are installed, peel the decals from the sides of the front handles. Place the instrument face down on its handles and remove the four mounting screws (two upper and two lower) which secure the lateral cross bracket to the front panel at the rear of the A1 PCB.

n. Disconnect the A1 PCB guard wire from the lower guard by removing the lug screw.

o. Place the instrument normal side down and remove all the screws from the sides of both front handles, or from the front corner panels in the event the instrument was rack mounted.

p. Pull the entire front panel assemblies free of the instrument, and at the same time, dislodge those PCB's which may be still inserted into the A1 motherboard.

q. To separate the A1 and A7 PCB pair from the front panel, remove the large screws that secure the PCB pair to the front panel by means of the teflon standoffs.

r. To separate the A1 and A7 PCB pair from each other after they are removed from the front panel, remove all the small screws from the A1 PCB. Separate the A1 and A7 PCB by pulling the two boards perpendicularly apart.

s. Assembly of the instrument is accomplished by reversal of the order of disassembly, with attention to connection of the A2 PCB guard wire that was removed in step o.

t. The air filter and blower are removed from the rear panel by removing the filter cover screws, the filter cover, the filter, the blower screws, and the blower line power plug.

u. Instructions for cleaning and installation of the air filter are given on the frame of the filter itself. See paragraph 4-10.

4-15. INVERTED CONTROL LOGIC

4-16. The Isolated Control Logic PCB can be altered to provide inverted logic levels. This is accomplished by jumpering to appropriate PCB pads. Refer to the table on the A6 Isolated Control Logic Schematic Diagram (4275A-1021, sheet 1 of 2). The table indicates the proper jumper configuration for normal and inverted logic levels for each model of the 4200 series instruments. Jumper locations are identified by alphabetical designations which appear on the schematic diagram and the PCB.

NOTE

The same Isolated Control Logic PCB Assembly is used in all models of the 4200 series instruments. However, the PCB's are not interchangeable until the jumper configuration is changed in accordance with the table on the 4275A-1021 schematic diagram. Therefore, insure that any control logic assemblies used as replacements conform to the jumper configuration shown in the table before installing the assembly in the instrument.

4-17. CALIBRATION PROCEDURES

4-18. The recommended period between successive calibrations for this instrument is 90 days or annually. The instrument must be calibrated following repairs. Use the test equipment defined in paragraph 4-2. Table 4-1. Assembly, adjustment, and test point locations are shown in Fgirue 4-1. Table 4-2 shows binary by decade coding for output magnitude control.

Table 4-1. RECOMMENDED TEST EQUIPMENT

NOMENCLATURE	EQUIPMENT
AC/DC Voltmeter	FLUKE Model 887A
Manual Control Unit (MCU)	FLUKE Model A4200
*AC Source, ±0.02% of output, 400 Hz	FLUKE Model 510A, Option −04
**Resistive Load	10 ohm ±1%. 20w
*Required only if −03 Option is installed.	
**Required only if −06 Option is installed.	

4-19. Initial Procedure

a. Turn off the instrument and remove the top dust cover screws. Leave the dust cover in place.

b. Connect the Model A4200 Manual Control Unit (MCU) to the programming connector on the rear of the instrument.

CAUTION!

The Model A4200 Manual Control Unit (MCU) is not compatible with 4200 series instruments equipped with the −09 Option. DO NOT connect the MCU to these instruments.
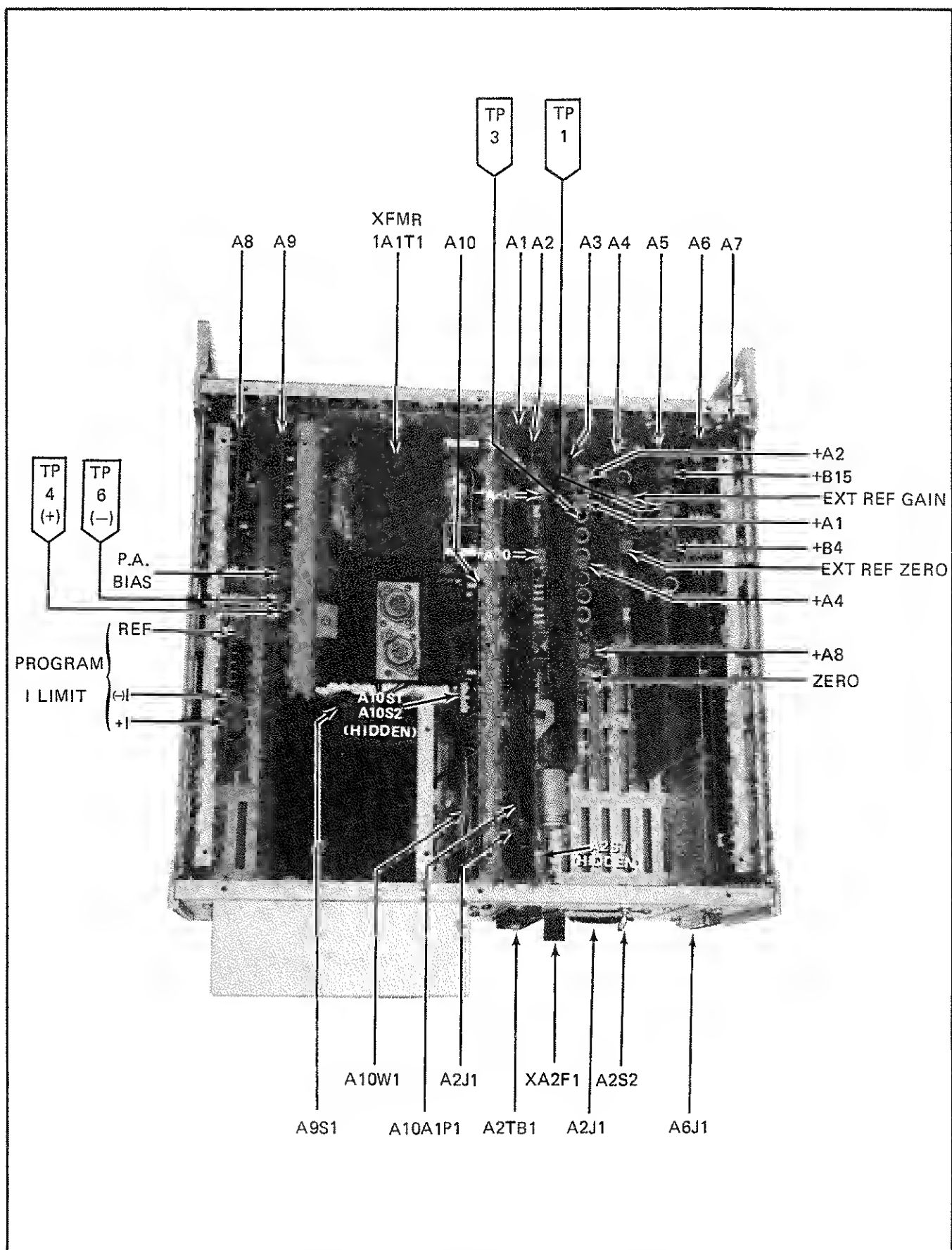
Figure 4-1. ASSEMBLY, ADJUSTMENT, AND TEST POINT LOCATIONS

Table 4-2. BINARY 8Y DECADE CODING

DECADE CODING		OUTPUT VOLTAGE (VDC)	
		10V RANGE	x10V RANGE
D DECADE	1	.001	.01
	2	.002	.02
	4	.004	.04
	8	.008	.08
C DECADE	1	.01	.1
	2	.02	.2
	4	.04	.4
	8	.08	.8
B DECADE	1	.1	1
	2	.2	2
	4	.4	4
	8	.8	8
A DECADE	1	1	10
	2	2	20
	4	4	40
	8	8	80

CAUTION!

On the rear panel barrier strip the following terminals must be jumpered: OUTPUT HI to SENSE HI and SENSE LO to OUTPUT LO to GUARD.

c. Turn on the instrument in accordance with Operating Instructions, paragraphs 2-6 and 2-7. Depress the MANUAL button on the MCU and release all other buttons that may be depressed.

NOTE!

In an instrument containing an A6 Inverted Isolated Control Logic PCB (—08 Option) all instructions reading depress shall mean release and all instructions reading release shall mean depress. This note, however, is not applicable to EXT REF, STANDBY, STROBE, MANUAL AUTO or EXT functions.

d. Depress the STROBE button on the MCU (0 volt, positive, low range) and allow the instrument to warm up for one-half hour.

4-20. Power Amplifier Bias Adjustment

a. Remove the top dust cover. Depress RANGE and STROBE buttons to call a 0V output, high range.

Check that the 110 VOLT RANGE indicator illuminates.

NOTE!

If the A8 Current Limiter PCB is installed (—06 Option), depress the following buttons for a current limit condition of 0.55 amperes: X10, 80, 20, 10, and STROBE. Check that these indicators illuminate: CURRENT LIMIT MA X10, 40, and 5.

b. Remove the guard cover and connect a dc voltmeter to A9TP4 (+) and A9TP6 (—). See Figure 4-1 for location of test points.

c. Adjust P.A. BIAS, as necessary, to obtain a meter reading in the range of 70mV to 278mVdc.

d. Disconnect the voltmeter from A9TP4 and A9TP6.

4-21. Bit Adjustment (0.4)

a. Connect a dc voltmeter to the OUTPUT HI (+) and LO (—) terminals on the rear panel barrier strip.

b. Connect an insulated shorting jumper between A3TP3 and A5TP1.

c. Release the RANGE button and depress the STROBE button to select 0V output on the 10 volt range. Check that the 110 VOLT RANGE indicator goes out.

d. Adjust A3, ZERO for a 0Vdc $\pm 10\mu V$ output.

e. Depress the B decade 8 and STROBE buttons. Check that the output voltage is about +8Vdc and that the B decade 8 indicator is on.

f. Record the exact dc voltage read in step e. and then divide the recorded value by 2 for a final value; e.g. 8.00383Vdc $\div$ 2 = 4.00192Vdc.

Recorded value_____

$\div$ 2 = _____ Final Value

g. Release the B8 button and depress the B4 and STROBE buttons. Check that the output voltage is about 4Vdc and that only the B decade 4 indicator is on.

h. Adjust A5, +B4 for an output that is within $\pm 100\mu V$ of the final value computed in step f.; e.g., 4.00192Vdc $\pm 100\mu V$.

i. Release the B4 button, depress STROBE, and remove the jumper between A3TP1 and A5TP1. Install the guard cover and insert all guard cover screws. Check that the B decade 4 indicator is out.

4-22. Zero, Reference, and Bit Adjustments

a. Release all MCU buttons except MANUAL, and depress RANGE and STROBE to obtain 0V output in the high range. Check that the 110 VOLT RANGE indicator is on and that the dc voltmeter is connected as defined in step 4-19. a.

b. Adjust A3, ZERO for 0Vdc $\pm 70\mu$V output, using an insulated screwdriver or tuning tool.

c. Release RANGE and depress STROBE. Check that 110 VOLT RANGE is out and that the output is 0Vdc $\pm 10\mu$V. Repeat steps a., b., and c. to achieve this tolerance, if necessary.

d. Depress RANGE, POL, A decade 8 and STROBE for a -80V, high range output. Check that 110 VOLT RANGE and SIGN indicators are on.

e. Adjust A2, $-$A80 for an output of -80Vdc ± 1mV.

f. Release POL and depress STROBE for a $+80$V high range output. Check that SIGN goes out and the A decade 8 stays on.

g. Adjust A2, +A80 for an output of $+80$Vdc ± 1mV.

h. Release RANGE, depress STROBE, and check that 110 VOLT RANGE goes out and the A decade 8 stays on.

i. Adjust A3, +A8 for an output of $+8$Vdc $\pm 100\mu$V.

j. Release A decade 8, depress A decade 4 and STROBE. Check that only A decade 4 indicator light is on.

k. Adjust A3, +A4 for an output of $+4$Vdc $\pm 100\mu$V.

l. Release 4, depress 2 and STROBE. Check that only A decade 2 indicator light is on.

m. Adjust A3, +A2 for an output of $+2$Vdc $\pm 100\mu$V.

n. Release 2, depress 1 and STROBE. Check that only A decade 1 indicator light is on.

o. Adjust A3 +A1 for output of $+1$Vdc $\pm 10\mu$V.

p. Release 1, depress B decade 8, 2, and 1, and STROBE. Check that B decade indicators 8, 2, and 1 come on.

q. Adjust A3, +B15 for an output of $+1.1$Vdc $\pm 10\mu$V.

r. Release all MCU buttons except MANUAL and depress STROBE. Check that output reads zero volts and that only the POWER indicator is on.

4-23. External Reference Adjustments (—03 Option)

4-24. If the A4 External Reference PCB Assembly is installed, perform the following adjustments:

a. Connect a shorting jumper between the EXT REF HI and EXT REF LO input terminals on the rear panel barrier strip.

b. Depress EXT REF, A decade 8, 4, 2, 1 and STROBE buttons. Check that EXT REF and A decade 8, 4, 2 and 1 indicators are on.

c. Adjust A4, EXT REF ZERO for an output of 0V $\pm 10\mu$Vdc.

d. Remove the shorting jumper from the rear panel barrier strip.

e. Apply a 10Vac $\pm 0.02\%$, 400 Hz signal to the EXT REF HI and LO terminals. Measure and record the actual ac voltage applied to these terminals with an ac voltmeter.

Recorded value

f. Disconnect the ac voltmeter and connect it to the OUTPUT HI and LO terminals on the same barrier strip.

g. Release A decade 4 and 1 buttons and check that the A decade 8 and 2 indicators are on.

h. Adjust A4, EXT REF GAIN for an ac output that is within $\pm 500\mu$V of the value recorded in step e.

i. Release A decade 8 and 2 buttons and depress STROBE. Check that the output is 0V and that all decade indicators are out.

j. Disconnect the ac signal source and set the ac voltmeter to measure dc volts.

4-25. Current Limiter Adjustment (—06 Option)

4-26. Adjustment of the A8 current limiter, when installed, is performed as follows:

a. Turn off the instrument and install a 10Ω $\pm 1\%$, 20W resistor between the OUTPUT HI and LO terminals. Leave the dc voltmeter connected.

b. Set the top dust cover in place, turn on the instrument, and release all MCU buttons that were depressed, except MANUAL.

c. Allow the instrument to operate for about one-half hour and then remove the top dust cover.

d. Depress POL, A decade 8, 2, 1, CURRENT LIMIT MA or % X10, 80, 20, and then STROBE. An −11Vdc output with a 100% current limit is called. Check that the following indicators are on: A decade 8, 2, 1, CURRENT LIMIT MA X10, 40, 10, and I LIMIT.

e. Adjust A8, REF for an output of −5Vdc ±15mV. Check that the I LIMIT indicator is on.

f. Release CURRENT LIMIT MA or % buttons X10, 80, and 20; depress 10 and STROBE. Check that CURRENT LIMIT MA or %5 indicator and I LIMIT indicator are on. This action calls the 5mA current limit (10 percent current limit).

g. Adjust A8, −I for output of −50mVdc ±0.5mV.

h. Release POL button, depress STROBE, and check that SIGN indicator goes out. This action calls a +11Vdc output.

i. Adjust A8, +I for an output of 50mVdc ±0.5mV.

j. Release CURRENT LIMIT MA or % 10 button and depress X10, 80, 20, and STROBE buttons. This action calls the 0.5A current limit (100 percent current limit). Check that the output is +5Vdc ±100mV, and that the following indicators are on: X10, 40, 10 and I LIMIT. Repeat the procedure starting at step d. if output is not within tolerance.

k. Release all MCU buttons and depress STROBE to call a 0V output. Also remove the 10 ohm resistor.

4-27. Final Zero Adjustment

4-28. The following adjustments must be performed only after the instrument has been operating for a minimum period of one-half hour with all covers in place.

a. Connect a dc voltmeter to OUTPUT HI and LO terminals on the rear panel barrier strip. Release all MCU buttons, except MANUAL, and depress STROBE. This action calls for a 0V output, positive in the low range. Check that only the POWER indicator is on.

b. Adjust AMPLIFIER ZERO (A3, ZERO) for an output of 0Vdc ±10μV.

c. Depress the RANGE and STROBE buttons. Check that the 100 VOLT RANGE indicator is on. This action calls the high or X10 range and 0V ±70μVdc output. If the output reading is not within tolerance, repeat steps a. through c.

d. If the A4 External Reference is installed (−03 Option), depress EXT REF, A decade 8, 4, 2, and 1 buttons and release RANGE. Depress STROBE and check that A decade indicators 8, 4, 2, 1 and EXT REF indicator illuminate.

e. Connect a shorting jumper between EXT REF HI and EXT REF LO terminals on the rear panel barrier strip.

f. Adjust EXT REF ZERO (A4, EXT REF ZERO) for an output of 0V ±10μV.

g. Remove the shorting jumper, release all MCU buttons, except MANUAL, depress STROBE, and check that the only indicator remaining on is POWER.

4-29. Output Checks

a. Perform the linearity checks given in Table 4-3, and check that the specified outputs are obtained. Connect an ac/dc voltmeter as described in step 4-26.a.

Table 4-3. LINEARITY CHECKS

CALLED OUTPUT					POWER SOURCE OUTPUT VOLTAGE (VDC)
SIGN (POLARITY)	A	B	C	O	
+	0	0	0	0	0V ±100 uv
+	0	1	1	1	+111mV ±120μV
+	0	2	2	2	+222mV ±120μV
+	0	3	3	3	+333mV ±130μV
+	0	4	4	4	+444mV ±140μV
+	0	5	5	5	+555mV ±150μV
+	0	6	6	6	+666mV ±160μV
+	0	7	7	7	+777mV ±180μV
+	0	8	8	8	+888mV ±190μV
+	0	9	9	9	+999mV ±200μV
+	0	10	10	10	+1.111V ±200μV
+	1	0	0	0	+1V ±0.2mV
+	2	0	0	0	+2V ±0.3mV
+	3	0	0	0	+3V ±0.4mV
+	4	0	0	0	+4V ±0.5mV
+	5	0	0	0	+5V ±0.6mV
+	6	0	0	0	+6V ±0.7mV
+	7	0	0	0	+7V ±0.7mV
+	8	0	0	0	+8V ±0.8mV
+	9	0	0	0	+9V ±0.9mV
+	10	0	0	0	+10 ±1mV
+	15	15	15	15	+16.665V ±1mV
−	15	15	15	15	−16.665V ±1mV

b. If the A4 External Reference PCB Assembly (−03 Option) is installed disconnect the ac/dc voltmeter, release all MCU buttons except MANUAL, and depress EXT REF and STROBE. Check that the EXT REF indicator comes on.

c. Apply a 10Vac, ±0.02%, 400 Hz signal and connect an ac/dc voltmeter to the EXT REF HI and LO input terminals on the rear panel barrier strip. Record the ac voltage indicated on the ac voltmeter.

Recorded value_____

d. Remove the ac voltmeter from the EXT REF HI and LO input terminals and connect it to the OUTPUT HI and LO terminals.

e. Depress A decade 1 button and STROBE; check that the A decade 1 indicator comes on and that the ac voltmeter reads within ±500µV of the level recorded in step c.

f. Depress RANGE, A decade 4, 2, 1; B decade 4, 2, 1; and STROBE buttons. The output should be 77Vac ±0.1V. Check that the 110 VOLT RANGE indicator is on, and that the 4, 2, and 1 indicators in both A and B decades are on.

g. Turn off the instrument and disconnect all test equipment.

h. Install the top dust cover. Calibration is complete and the instrument is ready for use.

Section 5
Lists of Replaceable Parts

5-1. INTRODUCTION

5-2.   This section contains an illustrated parts break-
down of the instrument. Components are listed alph-
numerically by assembly. Electrical components are listed
by item number. Each listed part is shown in an accompany-
ing illustration.

5-3.   Parts lists include the following information:

a.   Reference Designation or Item Number

b.   Description of each part

c.   Fluke Stock Number

d.   Federal Supply Code for Manufacturers. (See
Section 7 for Code-to-Name list.)

e.   Manufacturer's Part Number or Type.

f.   Total Quantity per assembly of component.

g.   Recommended Quantity: This entry indicates
the recommending number of spare parts necessary
to support one to five instruments for a period of
two years. This list presumes an availability of
common electronic parts at the maintenance site.
For maintenance for one year or more at an iso-
lated site, it is recommended that at least one in

each assembly in the instrument be stocked. In the
case of optional subassemblies, plug-ins, etc. that are
not always part of the instrument, or are deviations
from the basic instrument model, the REC QTY
column lists the recommended quantity of the
item in that particular assembly.

5-4. HOW TO OBTAIN PARTS

5-5.   Components may be ordered directly from the
manufacturer by using the manufacturer's part number, of
from the John Fluke Mfg. Co., Inc. factory or authorized
representative by using the FLUKE STOCK NUMBER. In
the event the part you order has been replaced by a new or
improved part, the replacement will be accompanied by an
explanatory note and installation instructions, if necessary.

5-6.   To ensure prompt and efficient handling of your
order, include the following information:

a.   Quantity

b.   FLUKE Stock Number

c.   Description

d.   Reference Designation or Item Number

e.   Printed Circuit Board Part Number

f.   Instrument Model and Serial Number

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	BCD PROGRAMMABLE POWER SOURCE	4270A	89536	4270A			
	Figure 5-1						
A1	Mother PCB Assembly (Figure 5-2)	332908	89536	332908	1		
A2	Power Supply PCB Assembly (Figure 5-3)	332940	89536	332940	1		
A3	Pre-Amplifier PCB Assembly (Figure 5-4)	332924	89536	332924	1		
A4	External Reference PCB Assembly (—03 Option) (Figure 5-5)	292581	89536	292581	1		
A5	BCD Ladder Assembly (Figure 5-6)	292565	89536	292565	1		
A6	Isolated Control Logic (Figure 5-7)	365692	89536	365692			
A7	BCD Display PCB Assembly (Figure 5-8)	302257	89536	302257	1		
A8	Current Limit PCB Assembly (—06 Option) (Figure 5-9)	332965	89536	332965	1		
A9	Power Amp PCB Assembly (Figure 5-10)	332957	89536	332957	1		
A10	High Voltage Power Supply Assembly Figure 5-11)	333005	89536	333005	1		
	Card Guide	229047	89536	229047	6		
	Card Guide	256461	89536	256461	1		
	Chassis, Side	296962	89536	296962	2		
	Connector, programming, male, 50 contact	307017	89536	307017	1		
	Cover, bottom	308122	89536	308122			
	Cover, guard	331884	89536	331884	1		
	Decal, corner	296269	89536	296269	1		
	Decal, Handle trim	295493	89536	295493	1		
	Decal, front panel	302034	89536	302034	1		
	Decal, rear panel	334516	89536	334516	1		
	Decal, side trim	295386	89536	295386	1		
	Fan, muffin, venturi	103374	89536	103374	1		
	Filter	313056	89536	313056	1		
	Handle, corner front	295667	89536	295667	2		
	Housing, filter	314047	89536	314047	1		

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	Panel, front	302034	89536	302034	1		
	Panel, rear	302042	89536	302042	1		
	Tray, guard	337493	89536	337493	1		
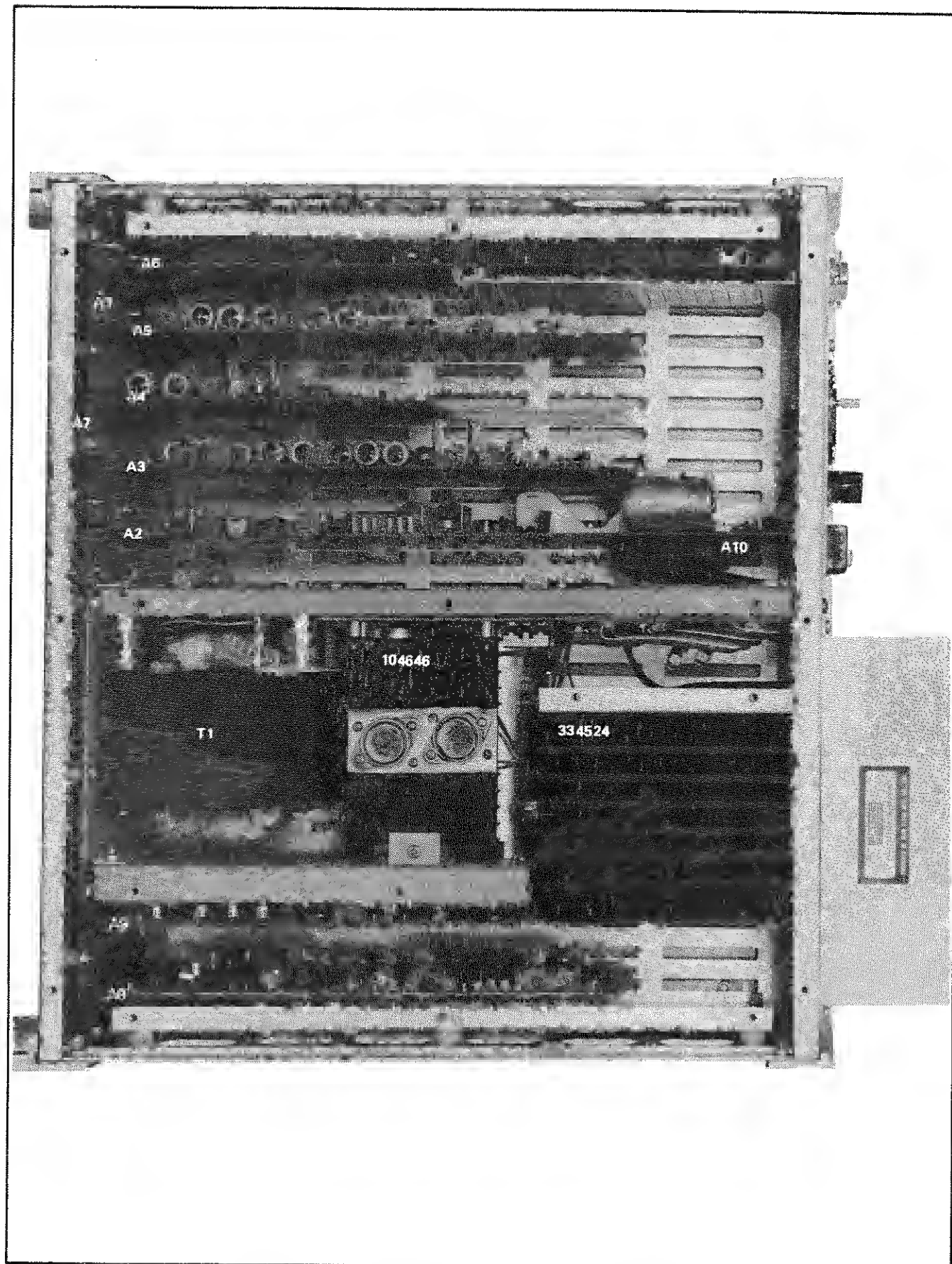
Figure 5-1.   BINARY PROGRAMMABLE POWER SOURCE

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A1	MOTHER PCB ASSEMBLY Figure 5-2	332908	89536	332908	REF		
J1 thru J7	Connector, femal, 50 contact	284604	02660	222-22501-110	7		

Figure 5-2. MOTHER PCB ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A2	POWER SUPPLY PCB ASSEMBLY **Figure 5-3**	332940	89536	332940	REF		
C1,C14, C17	Cap, cer, 0.05 uf +8-/—20%, 25V	148924	72982	5855-Y50-503Z	3		
C2,C5, C10,C19	Cap, mica, 33 pf± 5%, 500V	160317	71236	DM15E330J	5		
C3	Cap, mica, 100 pf± 5%, 500V	148494	71236	DM15F101J	1		
C4	Not used						
C6	Cap, cer, 500 pf ±10%, 1 kV	105692	71580	2DDH60N501K	1		
C7, C8	Cap, elect, 250 uf +50/—10%, 64V	185850	73445	C437ARH250	2		
C11,C12	Not Used						
C13,C16	Cap, elect, 8000 uf +100/—10%, 15V	309245	99392	61C15AS83	2		
C15	Not Used						
C18	Cap, Ta, 1.0 uf ±20%, 35V	161919	56289	196D105X0035	1		
C20	Cap, cer, 2000 pf, gmv, 1 kV	105569	71590	DA140-139CB	1		
C21	Cap, cer, 0.1 uf +80/—20%, 500V	105684	56289	41C92	1		
C22	Cap, plstc, 0.1 uf ±10%, 400V	289744	73445	C280CF/A100K	1		
C23,C24	Cap, cer, 1 uf ±gmv, 3V	106567	71590	UK105	2		
CR1, CR25, CR26	Diode, silicon, 1 amp, 600 piv	112383	05277	1N4822	3		
CR2, CR3, CR27, CR28, CR33, CR34, CR35	Diode, silicon, 150 ma	203323	03508	DHD1105	7	2	
CR4, CR14, CR19	Diode bridge, 2 amp	296509	09423	FB100	3	1	
CR5 thru CR8, CR10, thru CR13 CR15	Not Used						

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
CR16 thru CR18 CR20 thru CR22, CR24	Not used						
CR9, CR23	Diode, zener, 4.3V	180455	07910	1N749A	2		
CR29 thru CR32	Diode, Rectifier	329672	03508	1N5059	4		
F1	Fuse, slow blow, 2 amp, 250V (For 115V operation)	109181	71400	MDX	1		
J1	Connector, male, 3 contact, power	284166	82839	EAC301	1		
J2	Connector, female, 36 contact	236885	13511	225-21821-105	1		
K1	Relay, 4PDT, 5V Coil	272716	24796	R40-E030-1	1	1	
Q1,Q10, Q11,Q13 Q18,Q19, Q24	Xstr, silicon, NPN	218396	04713	2N3904	7		
Q2,Q3, Q5,Q6	Xstr, J-FET, N-channel	261578	15818	U2366E	4	2	
Q4,Q7, Q8,Q9, Q14	Xstr, silicon, PNP	195974	04713	2N3906	5		
Q12,Q17, Q23	Xstr, silicon, NPN	150359	95303	2N3053	3		
Q15,Q20	Xstr, silicon, PNP	269076	95303	2N4037	2		
Q16,Q21	Xstr, silicon, NPN	288381	95303	40372	2	1	
Q22	Xstr, J-FET, N-channel	271924	07910	CFE13041	1		
Q25	Xstr, J-FET, N-channel	288324	12040	SF50070	1	1	
R1,R55	Res, comp, 1 k ±5%, ¼W	148023	01121	CB1025	2		
R2	Res, met flm, 2.87k ±1%, 1/8W	185629	91637	MFF1-82R87F	1		
R3,R46	Res, met flm, 17.4k ±1%, 1/8W	236802	91637	MFF1-817R4F	2		
R4	Res, met flm, 5.76k ±1%, 1/8W	260349	91637	MFF1-85R76F	1		

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R6	Res, met flm, 13.7k ±1%, 1/8W	236752	91637	MFF1-813R7F	1		
R7,R8, R22, R24, R28, R30	Res, comp, 22k ±5%, ¼W	148130	01121	CB2235	6		
R9	Res, var, cermet, 20Ω ±20%, ½W	285114	71450	360S-200B	1		
R10 thru R13	Not used						
R14	Res, met flm, 40.2Ω ±1%, 1/8W	245373	91637	MFF1-840-250	1		
R15	Not used						
R17	Res, ww, 20.02k ±0.1% Matched Set	291674	89536	291674	1	1	
R18	Res, ww, 20k ±0.1%						
R19	Res, var, cermet, 50Ω ±10%, ½W	285122	71450	360S-500A	1		
R20	Res, met flm, 10k ±1%, 1/8W	168260	91637	MFF1-8102F	1		
R21	Res, met flm, 30.1k ±1%, 1/8W	168286	91637	MFF1-830R1F	1		
R23,R44	Res, comp, 10k ±5%, ¼W	148106	01121	CB1035	2		
R25,R26, R48	Res, comp, 3.9k ±5%, ¼W	148064	01121	CB3925	3		
R27,R29	Res, comp, 2k ±5%, ¼W	202879	01121	CB2025	2		
R31,R32, R38	Res, comp, 2.7k ±5%, ¼W	170720	01121	CB2725	3		
R33,R39	Res, comp, 4.7 5%, ¼W	193359	01121	CB47G5	2		
R34,R35	Not Used						
R36	Res, ww, 10k ±0.1%, ¼W	240945	89536	240945	1		
R37,R41	Res, ww, 4.02k ±0.1%, ¼W	240937	89536	240937	2		
R40	Res, ww, 3.74k ±0.1%, ¼W	246173	89536	246173	1		
R45,R49, R50,R53, R58,R60	Res, comp, 470 ±5%, ¼W	147983	01121	CB4715	6		
R47	Res, met flm, 3.74k ±1%, 1/8W	272096	91637	MFF1-83R74F	1		
R51,R52	Not Used						
R54	Res, comp, 22 ±5%, ½W	169847	01121	EB2205	1		

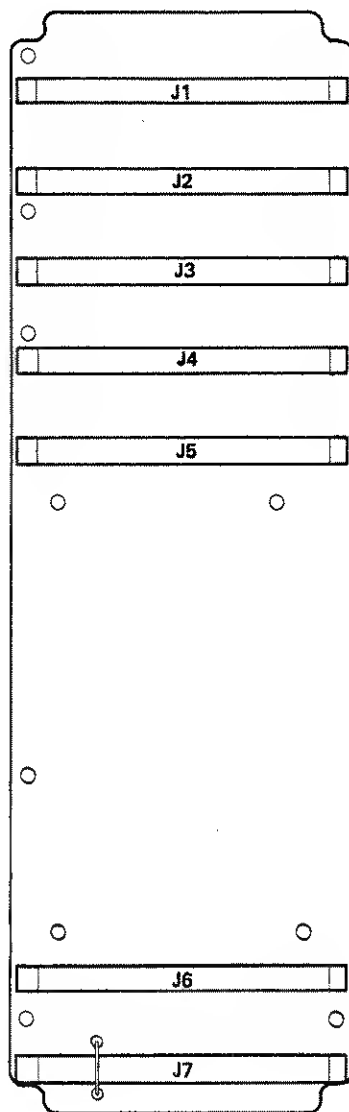| REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R57,R61	Res, comp, 10 ±5%, ¼W	147868	01121	CB1005	2		
R59	Res, factory selected value, may not be installed						
R62	Res, met flm, 7.15k ±1%, 1/8W	260356	91637	MFF1-87R15	1		
S1	Switch, slide, dpdt, line voltage	234278	82389	XW1649	1		
S2	Switch, toggle, dpdt, power	115113	95146	MST215N	1		
T1	Transformer, power (See Figure 5-1)	308239	89536	308239	1		
U1	IC, operational amplifier	271502	12040	LM301A	1		
U2	IC, reference amplifier						
R5	Res, met flm, selected value						
R16	Res, ww, 12k ±0.05%, ¼W Matched Set	301846	89536	301846	1		
R56	Res, ww, ¼W, selected value						
U3	IC, operational amplifier, selected	225961	89536	225961	1		
U4, U5	IC, operational amplifier	321224	34333	SG8178T	2		
TB1	Terminal barrier strip	295212	71785	TYPE 140Y	1		
XF1	Fuse holder	160846	75915	342004	1		
	Guard	297044	89536	297044	1		
	Socket, IC, 14 contact	276527	23880	TSA-2900-14W	1		
	Heat sink, Q12 & Q15	104646	05820	NF207	2		
	Jumper, terminal barrier strip	283713	71785	422-13-11-013	3		
U2,R5, R16,R56	Ref Amp Set	301846	89536	301846	1		
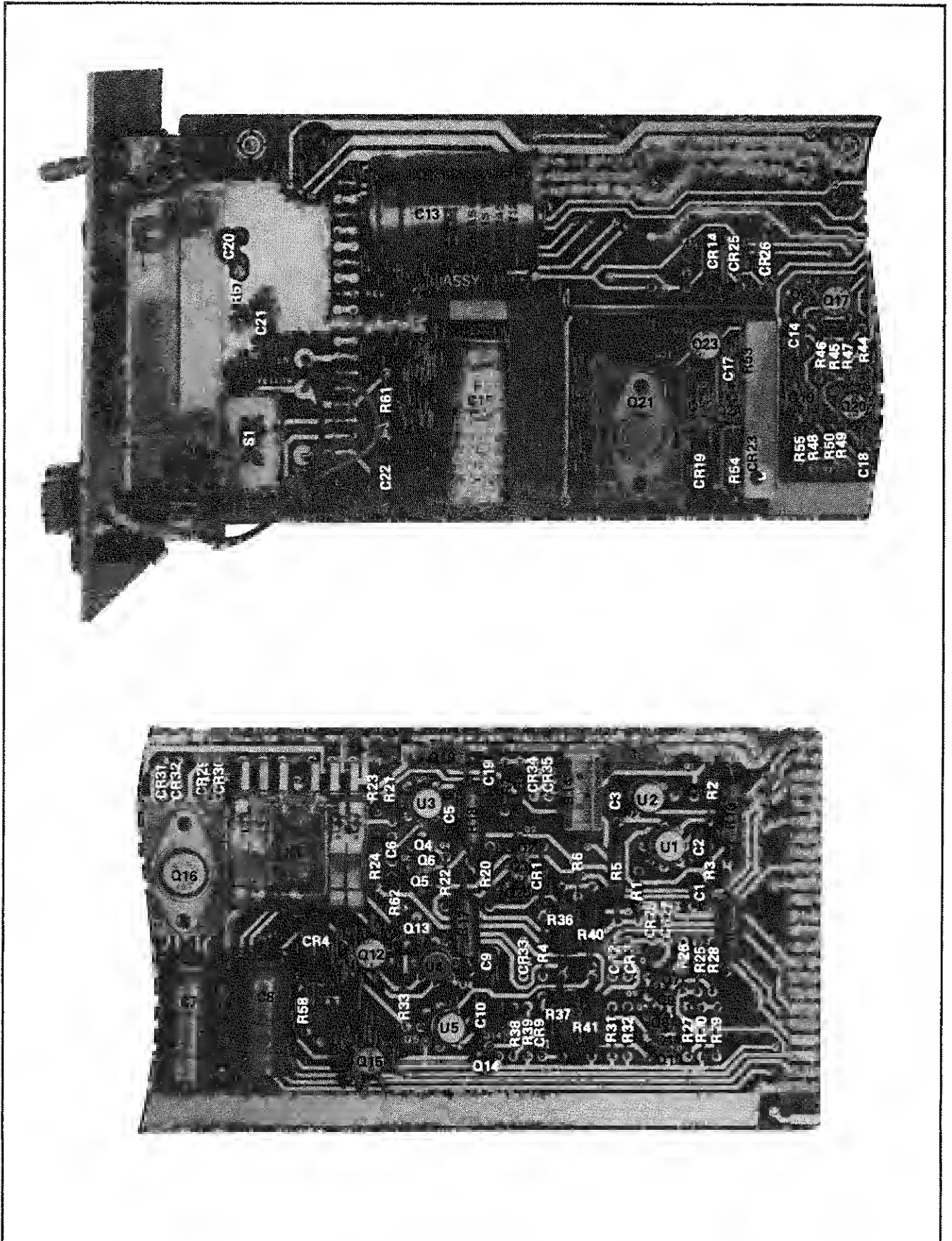
Figure 5-3. POWER SUPPLY PCB ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A3	PRE-AMPLIFIER PCB ASSEMBLY Figure 5-4	332924	89536	332924	REF		
C1	Cap, mica 1300 pF ±5%, 500	182881		DM195132J	1		
C2	Cap, mica 130 pF ±5%, 500V	266205	71236	DM15F131J	1		
C3	Cap, mica, 43 pF ±1%, 500V	277202	71236	DM15E430F	1		
C4	Not used						
C5	Cap, mica, 1000 pF ±5%, 500V	148387	71236	DM19F101J	1		
C6, C12	Cap, mica, 330 pF ±5%, 500V	148445	71236	DM15F331F	2		
C7, C8	Cap, elect, 20 uF +25/−10%, 50V	106229	56289	30D206G05CC4	2		
C9	Cap, elect, 50 uF +50/−10%, 25V	168823	56289	ET470X25A7	1		
C10	Cap, mica, 3600 pF ±2%, 500V	176644	71236	DM19F360G	1		
C11	Cap, mica, 3300 pF ±2%, 500V	192518	71236	DM19F330G	1		
C13	Cap, mica, 150 pF ±5%, 500V	148478	71236	DM15F151J	1		
C14,C16	Cap, cer, 0.05 ±20%, 100V	149161	56289	55C23A1	2		
C15	Cap, mica, 22 pF ±5%, 500V	148551	71236	DM15E220J	1		
CR1, CR2, CR5, CR6	Diode, silicon, 75 ma, 90 piv	260554	07910	CD55105	4		
CR3, CR4, CR7 thru CR12	Diode, silicon, 150 ma	203323	03508	DHD1105	8		
CR13, CR14	Diode, zener	342527	07910	TD333719	2		
Q1, Q2, Q3, Q6, Q7,Q10, Q11,Q14, Q15,Q31, Q32	Xstr, FET-SET, N-channel	256487	89536	256487	11		
Q4, Q8, Q12,Q16, Q34,Q37	Xstr, silicon, PNP	195974	04713	2N3906	6		

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
Q5, Q9, Q13,Q17, Q19,Q20, Q26,Q33, Q36	Xstr, silicon, NPN	218396	04713	2N3904	9		
Q18	Xstr, FET, dual, N-channel, selected	225987	89536	225987	1		
Q21, Q22, Q35	Xstr, FET, P-channel	306142	05397	3N173	3		
Q23	Xstr, silicon, NPN	159855	07910	CS23030	1		
Q24,Q25	Xstr, silicon, PNP, dual	242016	07263	SE4901	2		
Q27,Q28	Xstr, silicon, NPN	269084	07910	CS2484	2		
Q29	Xstr, silicon, NPN	150359	95303	2N3053	1		
Q30	Xstr, J-FET, N-channel	288324	12040	SF50070	1		
R1, R3, R7, R9, R13,R15, R19,R21, R38,R41	Res, comp, 51k $\pm$5%, ¼W	193334	01121	CB5135	10		
R2, R8, R14,R20, R47 thru R50,R70, R91	Res, comp, 100k $\pm$5%, ¼W	148189	01121	CB1045	10		
R4, R6, R10,R12, R16,R18, R22,R24, R44,R46	Res, comp, 2.7k $\pm$5%, ¼W	170720	01121	CB2725	10		
R5, R11 R17,R23	Res, comp, 560 $\pm$5%, ¼W	147991	01121	VN5615	4		
R25	Res, ww, 108k $\pm$0.1%, ½W						
R26	Res, ww, 25.013k $\pm$0.1%, ½W						
R27	Res, ww, 50k $\pm$0.1%, ½W						
R29	Res, ww, 100.025k $\pm$0.1%, ½W	333575	89536	333575	1		
R31	Res, ww, 200.075k $\pm$0.1%, ½W						
R35	Res, ww, 200.20k $\pm$0.1%, ½W						
R42,R43	Res, ww, 11.104k $\pm$0.1%, ½W						

Matched Set

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R28,R40	Res, var, cermet, 50 ±5%, 1W	285122	71450	360S-500A	2		
R30	Res, var, cermet, 100 ±10%, 1W	285130	71450	360S-101A	1		
R31	Not used						
R32	Res, var, cermet, 200 ±10%, 1W	285148	71450	360S-201A	1		
R33	Res, met flm, 3.32k ±1%, 1/8W	312652	91637	MFF1-83R32F	1		
R34	Res, met flm, 30.9k ±1%, 1/8W	235275	91637	MFF1-830R9F	1		
R36	Not used						
R37	Res, comp, 100m ±10%, ½W	190520	01121	EB1071	1		
R39	Not used						
R45	Res, comp, 1k ±5%, ¼W	148023	01121	CB1025	1		
R51	Res, comp, 1.5k ±5%, ¼W	148031	01121	CB1525	1		
R52,R53, R83,R86, R88	Res, comp, 5.1k ±5%, ¼W	193342	01121	CB5125	5		
R54	Res, met flm, 40.2k ±1%, 1/8W	235333	91637	MFF1-840R2F	1		
R55, R56, R63, R87	Res, comp, 10 ±5%, ¼W	147868	01121	CB1005	4		
R57	Res, met flm, 187k ±1%, 1/8W	296376	91637	MFF1-81873F	1		
R58	Res, met flm, 374k ± 1%, ½W	262105	91637	MFF1-23743F	1		
R59	Res, met flm, 750k ±1%, ½W	155192	91637	MFF1-2753F	1		
R60	Res, met flm, 1.27M ±1%, ½W	229252	91637	MFF1-21R27A1 F	1		
R61	Res, var, cermet, 100k ±10%, 1W	288308	71450	360S-104A	1		
R62	Res, met flm, 107k 1%, ½W	296384	91637	MFF1-21073F	1		
R64,R65	Res, ww, 6.8k ±0.03%, ½W	254359	89536	244359	2		
R67,R69	Res, met flm, 2k ±1%, 1/8W	277137	91637	MFF1-8202F	2		
R68	Res, met flm, 10k ±1%, 1/8W	291633	91637	MFF1-8103F	1		
R71	Res, comp, 22k ±5%, ¼W	148130	01121	CB2235	1		
R72	Res, comp, 10k ±5%, ¼W	148106	01121	CB1035	1		
R73,R75	Res, met flm, 49.9k ±1%, ½W	182890	91637	MFF1-249R9F	2		

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R74	Res, met flm, 2.1k ±1%, ½W	193276	91637	MFF1-22R1F	1		
R76,R80	Res, comp, 100 ±5%, ¼W	147926	01121	CB1015	2		
R77,R84	Res, met flm, 10k ±1%, ½W	151274	91637	MFF1-2103F	2		
R78,R85	Res, met flm, 4.87k ±1%, ½W	247775	91637	MFF1-24R87F	2		
R79	Res, met flm, 2.49k ±1%, ½W	193995	91637	MFF1-22R49F	1		
R81	Res, comp, 910 ±5%, ¼W	203851	01121	CB9115	1		
R82	Res, comp, 680 ±5%, ¼W	148007	01121	CB6815	1		
R89	Res, ww, 45 ±1%, 1/8W	111815	01686	TYPE R1250	1		
R90	Res, comp, 20k ±5%, ¼W	22164	01121	CB2035	1		
U1	IC, TTL, Monostable Multivibrator	293050	01295	SN74121N	1		
	Socket, IC, 14 contact	276527	23880	TSA-2900-14W	2		
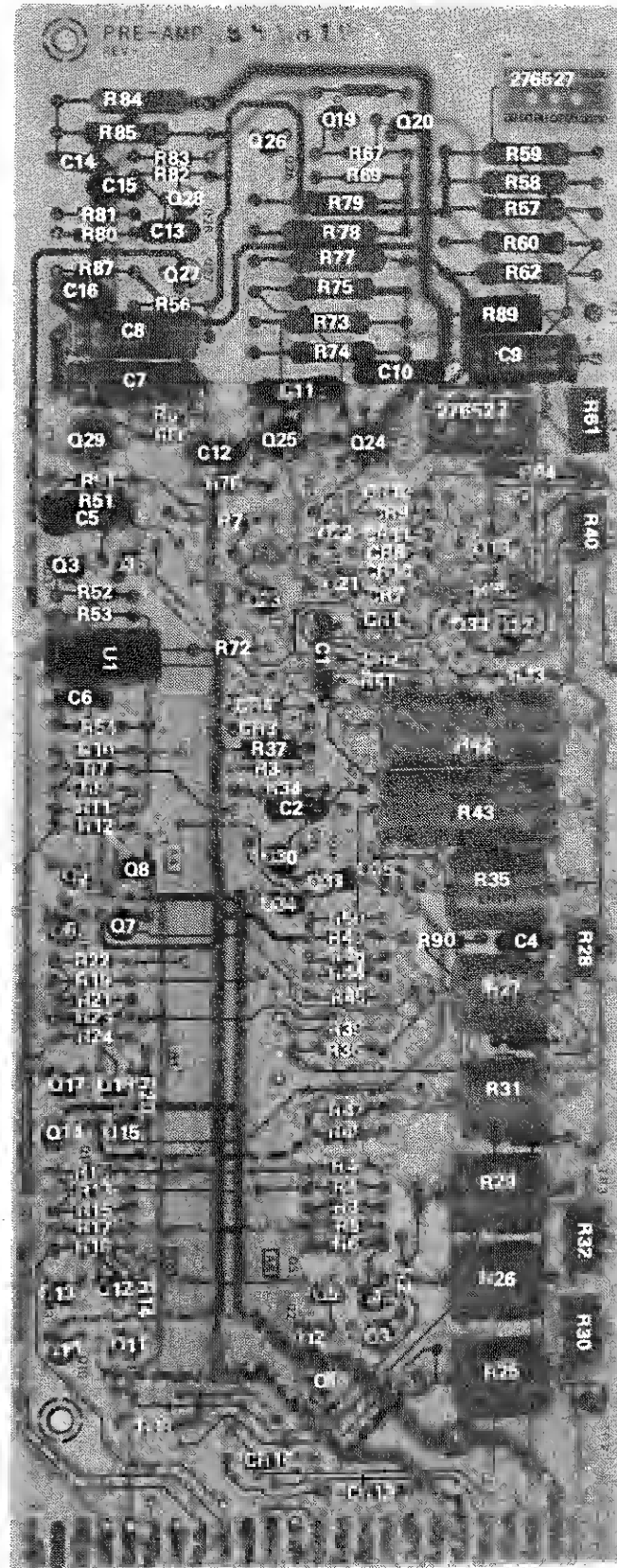
Figure 5-4.   PRE—AMPLIFIER PCB ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A4	EXTERNAL REFERENCE PCB ASSY. EXTERNAL REFERENCE **Figure 5-5 (—03 Option)**	292581	89536	292581	REF		
C1, C3	Cap, elect, 20 uf +75/—10%, 50V	106229	56289	30D206G05CC4	2		
C2	Cap, mica, 390 pf±5%, 500V	148437	71236	DM15F391J	1		
C4, C6	Cap, mica, 82 pf ±5%, 500V	148502	71236	DM15F820J	2		
C5	Cap, mica, 270 pf ±5%, 500V	148452	71236	DM15F271J	1		
C7, C11	Cap, cer, 0.05 uf ±20%, 100V	149161	56289	55C23A1	2		
C8, C9	Cap, mica, 5 pf ±10%, 500V	148577	71236	DM15C050K	2		
C10	Cap, mica, 22 pf ±5%, 500V	148551	71236	DM15E220J	1		
CR1 thru CR4	Diode, silicon, 150 ma	203323	03508	DHD1105	4		
Q1	Tstr, J-FET, dual, N-channel, selected	225987	89536	225987	1		
Q2, Q3, Q6,Q12	Tstr, silicon, NPN	218396	04713	2N3904	4		
Q4, Q5	Tstr, silicon, PNP, dual	242016	07263	SE4901	2		
Q7, Q8	Tstr, silicon, NPN	168716	07263	S19254	2		
Q9, Q10	Tstr, J-FET, N-channel	261578		U1897E	2		
Q11	Tstr, silicon, PNP	195974	04713	2N3906	1		
Q13,Q14	Tstr, silicon, NPN	150359	95303	2N3053	2		
R1 R16	Res, ww, 100.025k Matched Set Res, ww, 99.955k	291682	89536	291682	1		
R2,R11	Res, comp, 10 ±5%, ¼W	147868	01121	CB1005	2		
R3, R4	Res, ww, 6.8k ±0.03%, ½W	254359	89536	254359	2		
R5	Res, met flm, 107k ±1%, ½W	296384	91637	MFF1-21073F	1		
R6	Res, var, cermet, 100k ±10%, ½W	288308	71450	360S-104A	1		
R7	Res, met flm, 1.27M ±1%, ½W	229252	91637	MFF1-21275	1		
R8	Res, met flm, 750k ±1%, ½W	155192	91637	MFF1-2754F	1		
R9	Res, met flm, 374k ±1%, ½W	262105	91637	MFF1-23743F	1		
R10	Res, met flm, 187k ±1%, ½W	296376	91637	MFF1-21873F	1		

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R12	Res ww, 45 ±0.1%, 1/8W	111815	01686	TYPE 1250	1		
R13,R15	Res, met flm, 2k ±1%,1/8W	277137	91637	MFF1-8202F	2		
R14	Res, met flm, 10k ±1%, 1/8W	291633	91637	MFF1-8103F	1		
R17	Res, var, cermet, 100 ±10%, ½W	285130	71450	360S-101A	1		
R18,R20	Res, met flm, 49.9k ±1%, ½W	182980	91637	MFF1-249R9F	2		
R19	Res, met flm, 2.1k ±1%, ½W	193276	91637	MFF1-2212F	1		
R21,R35, R39	Res, comp, 100 ±5%, ¼W	147926	01121	CB1015	3		
R22	Res, comp, 5.1k ±5%, ¼W	193342	01121	CB5125	1		
R23,R28	Res, met flm, 10k ±1%, ½W	151274	91637	MFF1-2103F	2		
R24,R29	Res, met flm, 4.87k ±1%, ½W	247775	91637	MFF1-24R87F	2		
R25	Res, met flm, 2.49k ±1%, ½W	193995	91637	MFF1-22R49F	1		
R26	Res, comp, 1k ±5%, ¼W	148023	01121	CB1025	1		
R27,R36	Res, comp, 820 ±5%, ¼W	148015	01121	CB8215	2		
R30	Res, comp, 18k ±5%, ¼W	148122	01121	CB1835	1		
R31	Res, comp, 47k ±5%, ¼W	148163	01121	CB4735	1		
R32,R33	Res, comp, 3.9k ±5%, ¼W	148064	01121	CB3925	2		
R34	Res, comp, 2.7k ±5%, ¼W	170720	01121	CB2725	1		
R37	Res, comp, 4.7k ±5%, ¼W	148072	01121	CB4725	1		
R38	Res, comp, 270 ±5%, ¼W	160804	01121	CB2715	1		
	Socket, IC, 14 contact	276527	23880	TSA-2900-14W	2		
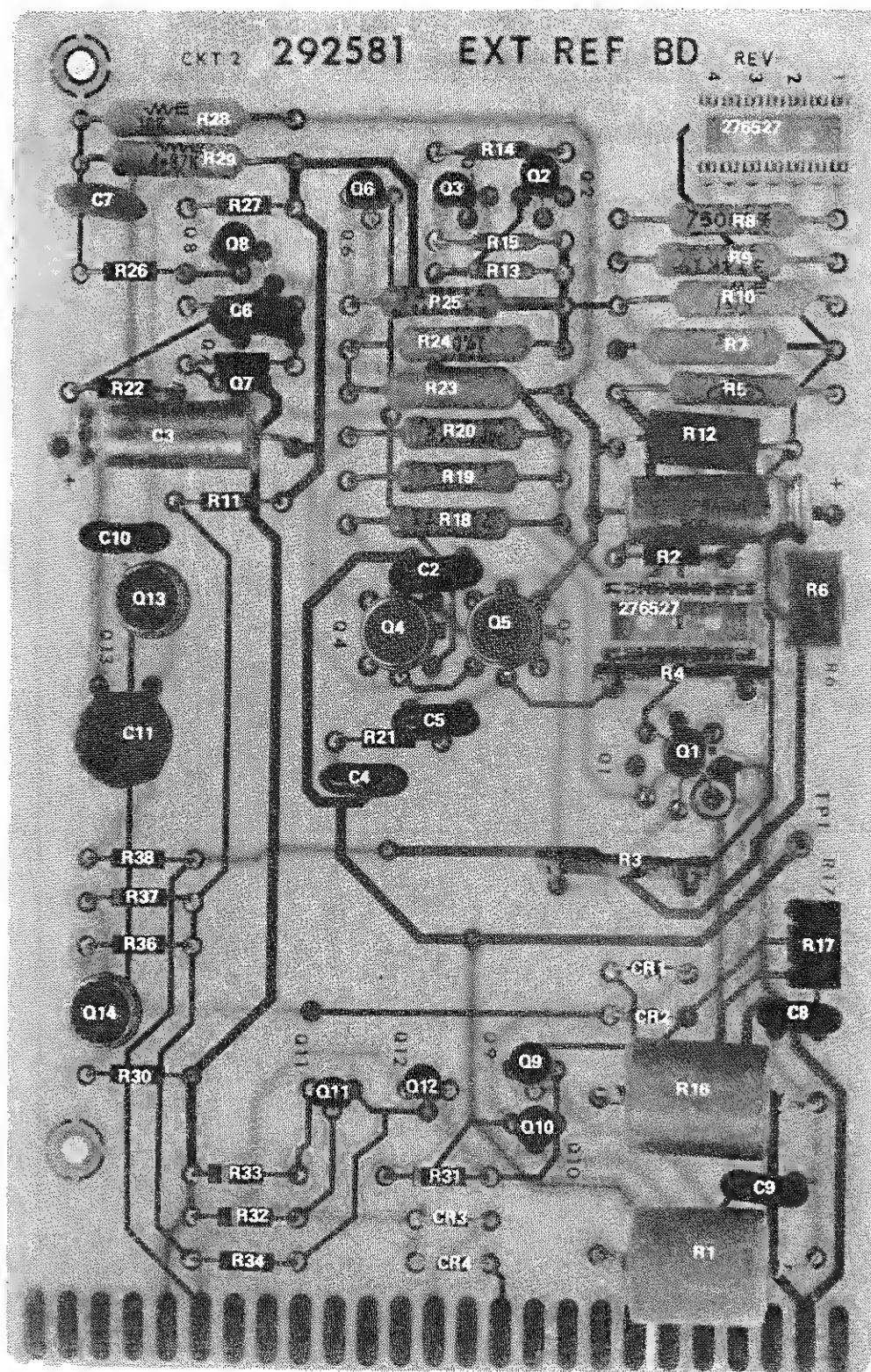
Figure 5-5.   EXTERNAL REFERENCE PCB ASSEMBLY (—03 OPTION)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A5	BCD LADDER PCB ASSEMBLY	292565	89536	292565	REF		
	Figure 5-6						
C1, C2	Cap, cer, 0.05 uf ±20%, 100V	149161	56289	55C23A1	2		
CR1	Diode, silicon, 150 ma	203323	03508	DHD1105	1		
Q1	Diode, Field Effect, current regulator	285106	07910	CRE3021	1		
Q2	Xstr, silicon, NPN	168716	07263	S19254	1		
Q3	Xstr, silicon, PNP	269076	95303	2N4037	1		
Q4	Not used						
Q5, Q9, Q13, Q17, Q21, Q25, Q29, Q33, Q37, Q41, Q45, Q49	Xstr, silicon, PNP	195974	04713	2N3906	12		
Q6, Q8	Xstr, J-FET, N-channel, U2366E, Matched Pair	306399	89536	306399	1		
Q7, Q11, Q15, Q19, Q23, Q27, Q31, Q35, Q39, Q43, Q47, Q51	Xstr, silicon, NPN	218396	04713	2N3904	12		
Q10, Q12	Xstr, J-FET, N-channel, U2366E, Matched Pair	306381	89536	306381	2		
Q14, Q16 Q18, Q20	Xstr, J-FET N-channel, U2366E Matched Pairs (Q14 matched to Q16; Q18 matched to Q20)	306373	89536	306373	2		
Q22, Q24, Q26, Q28, Q30, Q32, Q34, Q36, Q46, Q48, Q50, Q52	Xstr, J-FET, N-channel, U2366E, Matched Set	298299	89536	298299	1		
Q38, Q40, Q42, Q44	Xstr, J-FET, N-channel	261578	15818	U2366E	4		
R1	Res, var, cermet, 200 ±10%, ½W	285148	71450	360S-201A	1		
R2	Res, ww, 24.987k						
R3	Res, ww, 49.975k						
R5	Res, ww, 100.025k Matched Resistor Set	289827	89536	289827	1		
R6	Res, ww, 200.075k						
R7	Res, ww, 108k						

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R4	Res, var, cermet, 50 ±10%, ½W	285122	71450	360S-500A	1		
R8	Res, met flm, 60.4 ±1%, 1/8W	235366	91637	MFF1-860.4F	1		
R9	Res, ww, 24.987k ±0.03%, ¼W	289769	89536	289769	1		
R10	Res, ww, 50k ±0.03%, ¼W	289777	89536	289777	1		
R11	Res, met flm, 100.03k ±0.1%, 1/8W	291088	91637	MFF1-810032B	1		
R12	Res, met flm, 200.08k ±0.1%, 1/8W	290122	91637	MFF1-8200R08 B	1		
R13	Res, met flm, 108.06k ±0.1%, 1/8W	290114	91637	MFF1-8108R06 B	1		
R14	Res, met flm, 49.9k ±0.1%, 1/8W	291070	91637	MFF1-849R9B	1		
R15	Res, met flm, 24.9k ±0.1%, 1/8W	290106	91637	MFF1-824R9B	1		
R16	Res, met flm, 100k ±0.5%, 1/8W	291054	91637	MFF1-8104	1		
R17	Res, met flm, 200k ±1%, 1/8W	261701	91637	MFF1-8204F	1		
R18	Res, met flm, 120k ±1%, 1/8W	291062	91637	MFF1-8124F	1		
R19	Res, comp, 1.8k ±5%, ¼W	175042	01121	CB1825	1		B
R20	Res, comp, 20k ±5%, ¼W	221614	01121	CB2035	1		B
R23,R26, R29,R32, R35,R38, R41,R44, R47,R50, R53,R56, R59,R62, R65,R68, R71,R74, R77,R80, R83,R86, R89,R92	Res, comp, 2.7k ±5%, ¼W	170720	01121	CB2725	24		
R24,R30, R36,R42, R48,R54, R60,R66, R72,R78, R84,R90	Res, comp, 560 ±5%, ¼W	147991	01121	CB5615	12		B

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R25,R27, R28,R31, R33,R34, R37,R39, R40,R43, R45,R46, R49,R51, R52,R55, R57,R58, R61,R63, R64,R67, R69,R70, R73,R75, R76,R79, R81,R82, R85,R87, R88,R91, R93,R94	Res, comp, 51k ±5%, ¼W	193334	01121	CB5135	36		B
R21,R22	Not used						

Figure 5-6.   BINARY LADDER PCB ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A6	LOGIC ASSEMBLY	365692	89536	365692	REF		
	Figure 5-7						
C1	Cap, mylar, 0.001 uF ±10%, 200V	159582	56289	10292	1		
C2, C3	Cap, mica, 12 pF ±5%, 500V	175224	71232	DM15C120J	2		
C4, C47	Cap, mica, 100 pF ±1%, 500V	226126	71236	DM15F101F	2		
C5	Cap, Ta, 0.68 uF ±10%, 35V	182790	56289	150D684X935A	1		
C6	Cap, polyst, .0033 uF ±2%, 100V	168344	02799	PE-332-G	1		
C7, C8, C9, C29, C50	Cap, mica, 56 pF ±5%, 500V	148528	71236	DM15F560J	5		
C10	Cap, mica, 270 pF ±5%, 500V	148452	71236	DM15F271J	1		
C11 thru C15, C16 thru C25, C28, C34 thru C40, C43 thru C46	Cap, cer, 0.025 uF ±20%, 50V	168435	56289	C023B101H253M	27		
C26, C42	Cap, elect, 220 uF −10/+50%, 10V	236935	25403	ET221X010A5	2		
C27	Cap, cer, .0027 uF ±GMV, 600V	106211	56289	5GA-D33	1		
C30	Cap, mica, 620 pF ±5%, 500V	215244	71236	DM19F621J	1		
C31, C49	Cap, mica, 360 pF ±1%, 500V	170407	71236	DM15F361F	2		
C32	Cap, mica, 220 pF ±5%, 500V	170423	71236	DM15F221J	1		
C33	Cap, plstc, 0.10 uF ±10%, 500V	271866	06001	75F2R5A104	1		
C41	Not Used						
C48	Cap, polyst, 0.0075 uF ±2%, 100V	168369	02799	PE-752-G	1		
CR3, CR4	Diode, Hi-speed switching	256339	28480	5082-2900	2		
CR5 thru CR9	Diode, Si, 150 mA	203323	03508	DHD1105	5		
Q1, Q3 thru Q15	Xstr, Si, NPN	159855	07910	CS23030	14		
Q2, Q16	Xstr, Si, uni-junction	268110	03508	2N6027	2		
R1	Res, met film, 523 ±1%, 1/8W	294835	91637	MFF1-85230F	1		

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R2, R13, R23,R24, R27,R29, R31,R33, R41,R44, R46,R50	Res, comp, 1.0k ±5%, ¼W	148023	01121	CB1025	12		
R3	Res, comp, 2.7 ±5%, ¼W	246744	01121	CB2705	1		
R4	Res, comp, 1.5k ±5%, ¼W	148031	01121	CB1525	1		
R5, R6, R7	Not used						
R8	Res, met film, 11.5k ±1%, 1/8W	267138	91637	MFF1-81152F	1		
R9,R54	Re, comp, 100k ±5%, ¼W	148189	01121	CB1045	2		
R10,R55	Res, comp, 390k ±5%, ¼W	193383	01121	CB3945	2		
R11,R58	Res, comp, 390 ±5%, ¼W	147975	01121	CB3915	2		
R12	Res, comp, 1.3k ±5%, ¼W	234252	01121	CB1325	1		
R14	Res, met film, 32.4k ±1%, 1/8W	182956	91637	MFF1-83242F	1		
R15	Res, comp, 12k ±5%, ¼W	159731	01121	CB1235	1		
R16,R37 thru R40 R42,R60	Res, comp, 200 ±5%, ¼W	193482	01121	CB2015	7		
R17,R21, R25,R51	Res, comp, 510 ±5%, ¼W	218032	01121	CB5115	4		
R18,R36, R45,R47, R48,R49, R59	Res, comp, 3.3k ±5%, ¼W	148056	01121	CB3325	7		
R19,R20	Res, met film, 6.98k ±1%, 1/8W	261685	91637	MFF1-86981F	2		
R22,R26, R28,R30, R32,R43	Res, comp, 51 ±5%, ¼W	221879	01121	CB5105	6		
R34	Res, met film, 13k ±1%, 1/8W	335539	91637	MFF1-8133F	1		
R35	Not used						
R52,R56	Res, met film, 10k ±1%, 1/8W	168260	91637	MFF1-8103F	2		
R53	Res, met film, 28k ±1%, 1/8W	291385	91637	MFF1-8283F	1		
R57	Res, comp, 27k ±5%, ¼W	148148	01121	CB2735	1		

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R61	Res, comp, 5.1k ±5%, ¼W	193342	01121	CB5125	I		
T1 thru T6	Xfmr	299594	89536	299594	6		
U1, U2	IC, TTL, MSI, 8-Input Multiplexer	326165	07263	9313	2		
U3, U16	IC, TTL, Hex Inverter	293076	01295	SN74H04N	2		
U4	IC, TTL, MSI, Digital Multiplexer	288852	04713	MC8312	1		
U5	IC, TTL, MSI, Synchronous 4-bit up-down counter	293183	01295	SN74193N	1		
U6, U26	IC, TTL, Hex Inverter	292979	01295	SN7404N	2		
U7	IC, TTL, JK Master-Slave Flip-Flop	296491	01295	SN7472N	I		
U8, U17	IC, TTL, Dual Retriggerable Monostable Multivibrator	310235	01295	SN74123N	2		
U9	IC, TTL, Dual 2 Wide, 2-Input and-or-inverter gate	293084	01295	SN74H51N	1		
U10	IC, TTL, JK Negative Edge Triggered Flip-Flop with AND Inputs	293092	01295	SN74H102N	1		
U11	IC, TTL, Quadruple, 2-Input Positive AND gate	292987	01295	SN7408N	I		
U12	IC, TTL, Quad, 2-Input NAND Gate	292953	01295	SN7400N	1		
U13,U14	IC, TTL, Dual Peripheral Pos NAND Driver	329706	01295	SN75452P	2		
U15,U18	IC, TTL, Monostable, Multivibrator	293050	01295	SN7412 IN	2		
U19	IC, TTL, Retriggerable Monostable Multivibrator	293134	07263	U6A960159X	1		
U20,U21, U22	IC, TTL, 8-bit Parallel outshift register	272138	01295	SN74164N	3		
	Connector, female	267252	13511	57-40360	I		
	Guard, logic	331785	89536	331785	1		
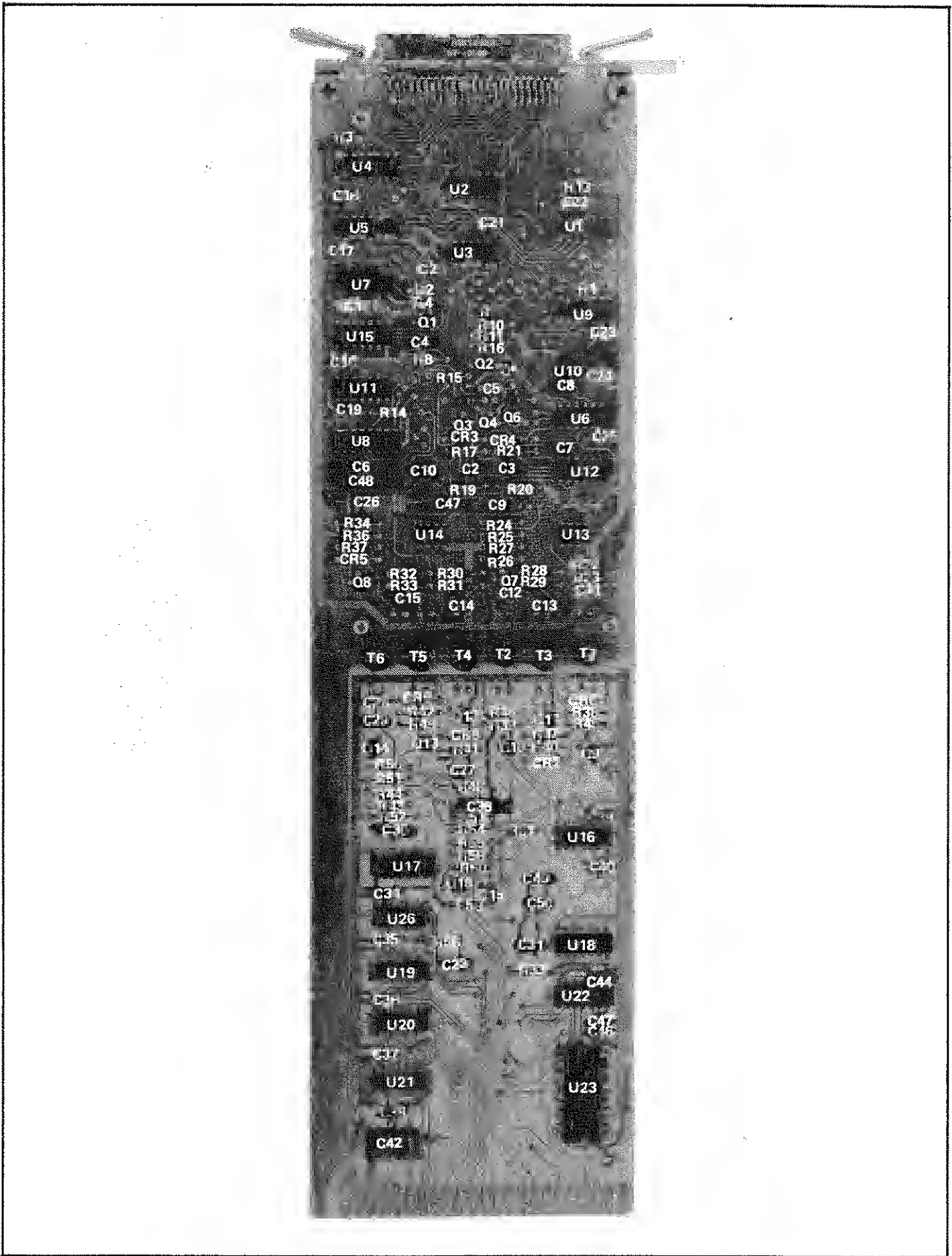
Figure 5-7.   ISOLATED CONTROL LOGIC

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A7	BCD DISPLAY PCB ASSEMBLY PANEL DISPLAY OPTION	302257	89536	302257	REF		
	Figure 5-8						
CR1 thru CR27	Diode, light emitting	309617			27		
R1 thru R27	Res, comp, 270 ±5%, ¼W	160804	01121	CB2715	27		
U1 thru U5	IC, TTL, Hex Inverter	292979	01295	SN7404N	5		
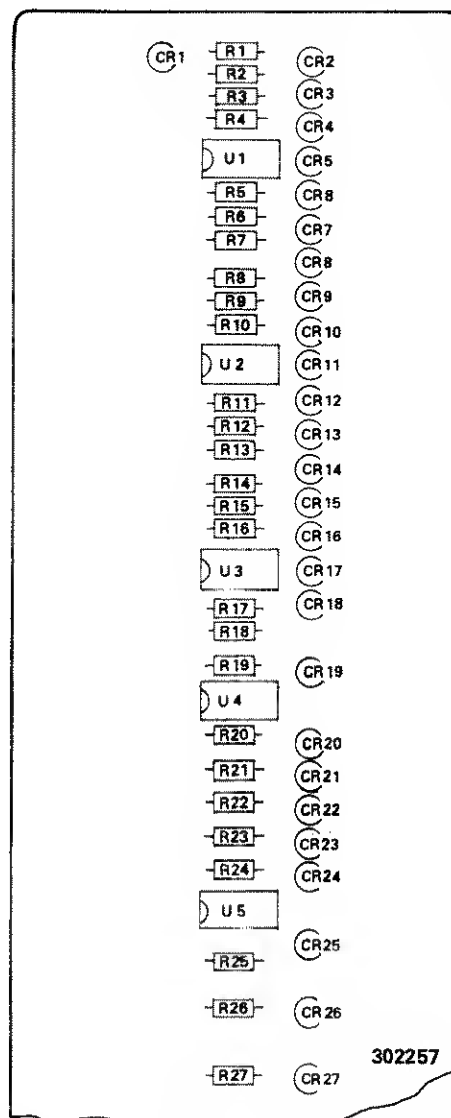
Figure 5-8. BCD DISPLAY PCB ASSEMBLY

CURRENT LIMIT PCB ASSEMBLY (−06 Option)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A8	CURRENT LIMIT PCB ASSEMBLY (−06 Option) Figure 5-9	332973	89536	332973	REF		
C1, C2, C12	Cap, plstc, 0.1 µf ±10%, 250V	161992	73445	C280AE/ A100K	3		
C3	Cap, mica, 10 pf ±10%, 500V	175216	71236	DM15C100K	1		
C4, C5	Cap, plstc, 0.033 µf ±10%, 200V	106062	56289	192P33392	2		
C6	Cap, mica, 4 pf ±5%, 500V	190397	73236	DM15C040J	1		
C7	Cap, mica, 27 pf ±5%, 500V	177998	71236	DM15E270J	1		
C8, C9, C13, thru C16	Cap, cer, 0.0012 µf ±10%, 500V	106732	71590	CP122	6		
C10, C11	Cap, mica, 33 pf ±5%, 500V	160317	71236	DM15E330J	2		
C17	Cap, plstc, 0.022 µf ±10%, 250V	234484	73445	C280AE/A22K	1		
CR1, CR2	Diode, zener, 16V	113332	07910	1N966A	2		
CR3, CR5, CR10, CR11	Diode, zener, 20 mA, 3.9V	113316	07910	1N748	4		
CR4, CR8,	Diode, zener, 12.5 mA	246611	07910	1N961B	2		
CR6, CR9	Diode, zener, 36V	186163	07910	1N974B	2		
CR7	Diode, zener, 6.3V, 7.5 mA	172148	03877	1N3496	1		

CURRENT LIMIT PCB ASSEMBLY (—06 Option) Cont.

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
Q1,Q2, Q5,Q8, Q11,Q14, Q16, Q19, Q20	Xstr, Si, NPN	218396	04713	2N3904	9		
Q3,Q7, Q10,Q13, Q15, Q21, Q23	Xstr, Si, PNP	195974	04713	2N3906	7		
Q4,Q6, Q9, Q12, Q26	Xstr, J-FET, N-channel	261578	07910	U2366E	5		
Q17	Xstr, semicon, Si, PNP, dual	242016	07263	SE 4901	1		
Q18	Xstr, Si, PNP	276899	95303	2N5415	1		
Q22	Xstr, Si, PNP	284448	95303	2N5416	1		
Q24, Q28	Xstr, Si, NPN	218511	95303	60994	2		
Q25	Xstr, Si, NPN	220087	24355	00/17	1		
Q27	Xstr, Si, NPN	335067	04713	2N3439	1		
R1	Res, comp, 39k ±5%, 1W	236729	01121	GB3935	1		
R2, R58	Res, comp, 8.2k ±5%, 2W	330555	01121	HB8225	2		
R3	Res, met flm, 649 ±1%, 1/8W	309955	91637	MFF1-8649F	1		
R4	Res, met flm, 750 ±1%, 1/8W	312801	91637	MFF1-8751F	1		
R5	Res, var, cermet, 500 ±10%, 1W	291120	71450	3608-501A	1		
R6	Res, met flm, 15 ±1%, 1/8W	296434	91637	MFF1-8151F	1		
R7, R56, R57	Res, comp, 2.7k ±5%, 2W	330548	01121	HB2725	3		

CURRENT LIMIT PCB ASSEMBLY (—06 Option) Cont.

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R8	Res, comp, 47k ±5%, ¼W	148163	01121	CB4735	1		
R9	Res, comp, 10k ±5%, ¼W	148106	01121	CB1035	1		
R10, R12, R16, R19, R22	Res, comp, 24k ±5%, ¼W	193425	01121	CB2435	5		
R11, R13, R17, R21, R23, R33	Res, comp, 12k ±5%, ¼W	159731	01121	CB1235	6		
R14, R18, R20, R32, R50	Res, comp, 27k ±5%, ¼W	148148	01121	CB2725	5		
R15, R54	Res, met flm, 6.19k ±1%, 1/8W	283911	91637	MFF1-86R19F	2		
R24, R25	Res, met flm, 10k ±1%, 1/8W	168260	91637	MFF1=8103F	2		
R26, R35	Res, comp, 5.1M ±5%, ¼W	294467	01121	CB5155	2		
R27	Res, comp. 5.1k ±5%, ¼W	193342	01121	CB5125	1		
R28, R34	Res, comp, 10M ±5%, ¼W	194944	01121	CB1065	2		
R29, R53	Res, var, cermet, 20k ±10%, ½W	291609	71450	360S-203A	2		
R30, R52	Res, met flm, 24.9k ±1%, 1/8W	291369	91637	MFF1-824R9F	2		
R31	Res, met flm, 2.74k ±1%' 1/8W	293761	91637	MFF1-82R74F	1		
R36, R49	Res, comp, 22k ±5%, 1W	330530	01121	GB 2235	2		

CURRENT LIMIT PCB ASSEMBLY (—06 Option)Cont.

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R37, R48	Res, comp 36k ±5%, ¼W	221929	01121	CB3635	2		
R38, R46	Res, comp, 39k ±5%, ¼W	188466	01121	CB3935	2		
R39, R47	Res, comp, 36k ±5%, 1W	109736	01121	CB3635	2		
R40, R45	Res, comp. 120 ±5%, ¼W	170712	01121	CB1215	2		
R41, R44, R59	Res, comp. 1.2k ±5%, ¼W	190371	01121	CB1225	3		
R42, R43	Res, comp, 100 ±5%, ¼W	147926	01121	CB1015	2		
R51	Res, ww, 2 ±1%, 2W	229542	56289	223E	1		
R55	Res, met flm, 12.4k ±1%, 1/8W	261644	91637	MFF1-812$4F	1		
R60, R61, R62	Res, comp 50 ±5%, ¼W	147900	01121	CB5605	3		
U1, U2	IC, Hex Inverter	268367	04713	MC 836P	2		
U3, U4	1C, Operational Amplifier	271502	12090	LM301A	2		
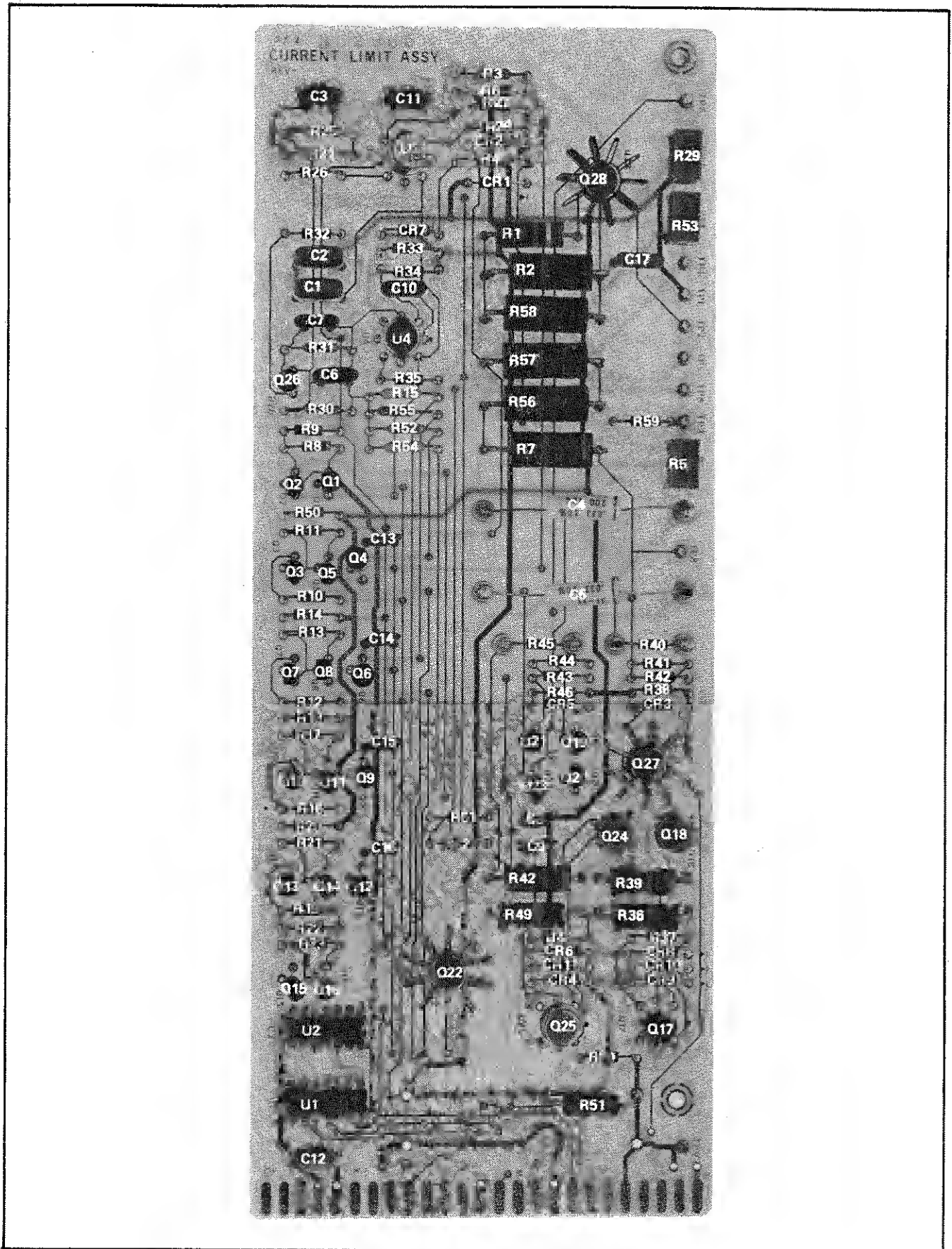
Figure 5-9. PROGRAMMABLE CURRENT LIMIT (−06 OPTION)

POWER AMPLIFIER ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A9	**POWER AMPLIFIER ASSEMBLY** **Figure 5-10**	332957	89536	332957	REF		
C1, C4	Cap, mica, 330 pf ±1%, 500V	226142	71236	DM15F331F	2		
C2, C3	Cap, mica 33 pf ±5%, 500V	160317	71236	DM15E330J	2		
C5, C9, C10, C16, C22	Cap, mica, 100 pf ±5%, 500V	148894	71236	DM15F101J	5		
C6	Cap, mica, 51 pf ±5%, 500V	277210	71236	DM15E510J	1		
C7, C15	Cap, elect, 10 µf +50/−10%, 150V	106351	56289	30D397F150 DD4	2		
C8	Not used						
C11, C13, C21	Cap, plstc, 0.47 µf ±10%, 250V	184366	73445	C280AE/A470K	3		
C12, C14, C17 thru C20	Not used						
C23	Cap, mica, 150 pf ±5%, 500V	148478	71236	DM15F151J	1		
C24, C25	Cap, cer, 0.005 µf ±20%, 50V	175232	56289	C023B101H253H	2		
C26, C27	Cap, cer, 0.01 µf ±20%, 100V	149153	56289	C023B101F103M	2		
C28, C29	Cap, mica, 10 pf ±10%, 500V	175216	71236	DM15C100K	2		

POWER AMPLIFIER ASSEMBLY (Cont)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
CR1 thru CR10, CR19, CR20, CR35, CR36, CR37	Diode, Si, 150 mA	203323	03508	DHD1105	15		
CR11	Not used						
CR12	Diode, zener, 6.8V	260695	07910	1N754A	1		
CR13	Not Used						
CR14, CR16, CR24, CR25, CR27 thru CR30, CR33, CR34, CR38, CR39	Diode, Si, 1 amp, 600 piv	112383	05277	1N4822	12		
CR15, CR17, CR18, CR21, CR22, CR23, CR26, CR31, CR32	Not Used						
CR40, CR41	Diode, FET	334714	07910	TCR 5315	2		
Q1	Xstr, Si, PNP	276899	95303	2N5415	1		
Q2, Q3, Q8, Q11, Q13, Q18, Q26, Q38	Xstr, Si, NPN	335067	04713	2N3439	8		

POWER AMPLIFIER ASSEMBLY (Cont)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
Q4, Q20, thru Q25	Xstr, Si, NPN	218511	95303	60994	6		
Q5, Q6, Q7, Q9, Q10, Q12, Q14, Q17, Q30	Xstr, Si, PNP	284448	05303	2N5416	9		
Q15, Q35	Xstr, Si, PNP	195974	04713	2N3906	2		
Q16, Q19, Q34	Xstr, Si, NPN	218396	04713	2N3904	3		
Q27, Q28, Q29	Not used						
Q31	Xstr, Si, NPN	190710	04713	2N3739	1		
Q32, Q33, Q41, Q42	Xstr, Si, NPN, power (on Heatsink)	313213	95303	2N5240	4		
Q36	Not used						
Q37	Xstr, Si, PNP, power	309302.	04713	2N5345	1		
Q39, Q40	Not used						
R1, R2, R9, R10, R23	Res, comp, 2k ±5%, ¼W	202879	01121	CB2025	5		
R3, R8, R69, R73	Res, comp, 20k ± 5%, ¼W	221614	01121	CB2035	4		
R4, R6	Res, comp, 62k ±5%, ¼W	220053	01121	CB6235	2		
R5, R7	Res, comp, 270 ±5%, ¼W	160804	01121	CB2715	2		

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R11	Res, met flm, 4.12k ±1%, 1/8W	235341	91637	MFF1-84R12F	1		
R12, R65, R67	Res, comp, 1k ±5%, ¼W	148023	01121	CB1025	3		
R13, R31, R40	Res, comp, 100 ±5%, ¼W	147926	01121	CB1015	3		
R14,R18	Res, comp, 250k ±5%, ¼W	218016	01121	CB2445	2		
R15, R19, R63	Res, comp, 330k ±5%, ¼W	192948	01121	CB3345	3		
R16,R17	Res, comp, 6.2k ±5%, ¼W	221911	01121	CB6225	2		
R20,R22	Res, comp, 10k ±5%, ¼W	148106	01121	CB1035	2		
R21	Res, met flm, 10k ±1%, 1/8W	168260	91637	MFF1-8103F	1		
R24	Res, met flm, 6.04k ±1%, 1/8W	285189	91637	MFF1-86R04F	1		
R25	Res, met flm, 15.8k ±1%, 1/8W	293688	91637	MFF1-815R8F	1		
R26,R33	Res, comp, 7.5k ±5%, ¼W	193326	01121	CB7525	2		
R27,R32	Res, comp, 130k ±5%, ½W	108852	01121	EB1345	2		
R28,R29	Res, comp, 180 ±5%, ¼W	147942	01121	CB1815	2		
R30	Res, comp, 33k ±5%, 1W	109538	01121	GB3335	1		
R34,R35	Not Used						
R36,R50, R60,R61, R68,R70, R71,R72	Res, comp, 100k ±5%, ¼W	148189	01121	CB1045	8		
R37,R53	Res, comp, 68 ±5%, ¼W	147918	01121	CB6805	2		
R38,R39, R56,R57	Res, comp, 1 ±5%, ¼W	218693	01121	EB10G5	4		
R41	Res, met flm, 23.7k ±1%, 1W	330506	91637	MFF1-23R7F	1		
R42,R45	Res, met flm, 127 ±1%, 1/8†	330944	91637	MFF1-8127F	2		
R43,R47	Res, comp, 1.1 ±5%, ½W	163717	01121	EB11G5	2		
R44,R46, R48	Not used						
R49	Res, comp, 51 ±5%, ½W	144717	01121	EB5105	1		

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R51	Res, var, cermet, 100 ±10%, 1W	285130	71450	360S-101A	1		
R52,R54, R55	Not used						
R58	Res, comp, 20k ±5%, 1W	330951	01121	GB2035	1		
R59	Not used						
R62	Res, met flm, 54.8k ±1%, 1/8W	271353	91637	MFF1-854R9F	1		
R64,R66	Res, comp, 1M ±5%, ¼W	182204	01121	CB1055	2		
	Heat Sink	302141	89536	302141	1		
	Conn, assy.	310771	89536	310771	5		
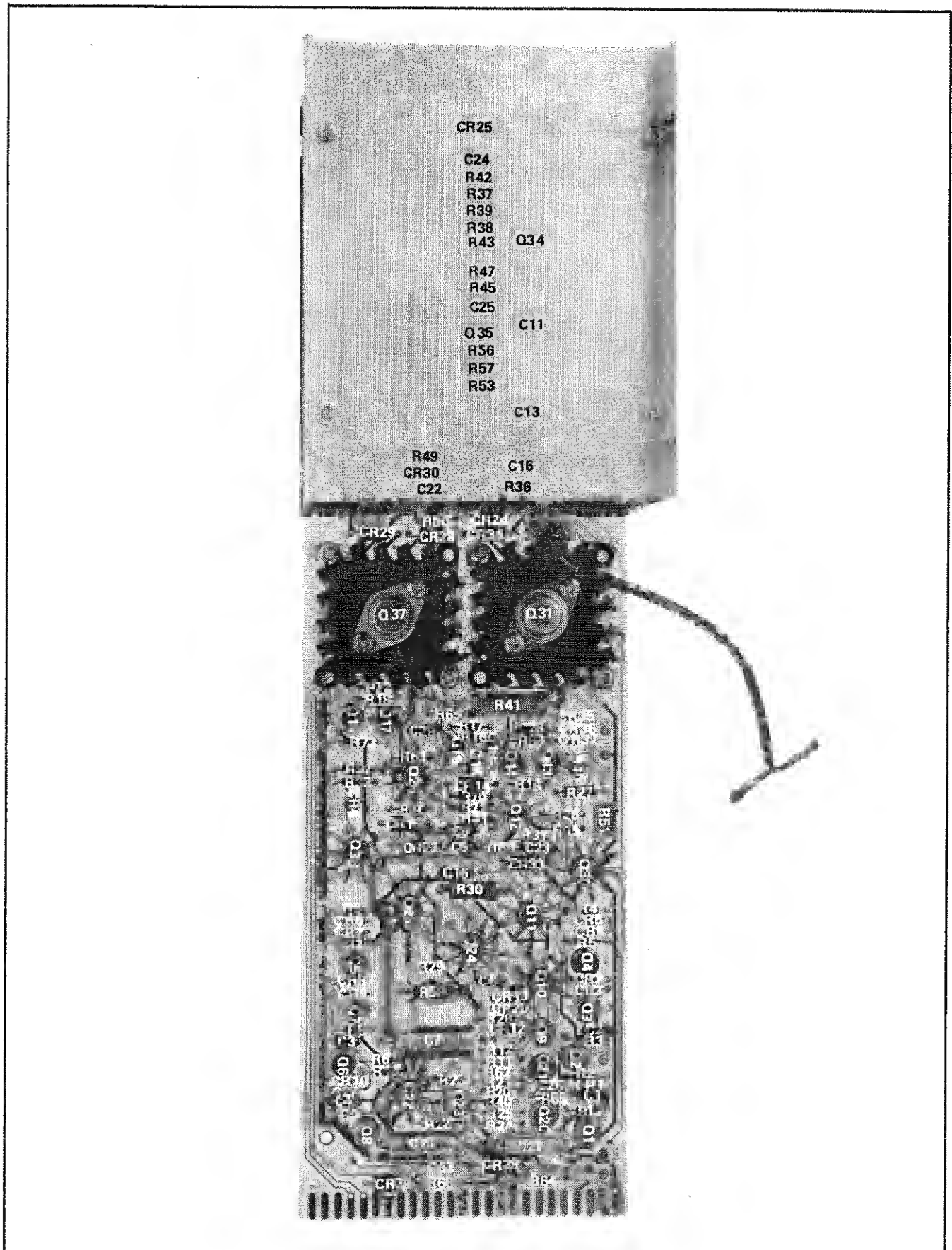
Figure 5-10. POWER AMPLIFIER

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A10	HIGH VOLTAGE POWER SUPPLY ASSY	333005	89536	333005	REF		
A10A1	High Voltage Power Supply PCB (Figure 5-11)	332916	89536	332916	1		
T1	Xfmr, power	333799	89536	333799	1		
	Cord Set	248708	82877	16415	1		
A10A1	High Voltage Power Supply PCB	332916			REF		
C1, C4, C6	Cap, cer, 0.01 uF ±20%, 500V	105668	56289	C023B501J103 M	3		
C2, C3	Cap, elect, 1200 uF +75/−10%, 250V	329953	56289	36D122G250BC 2B	2		
C5	Not used						
C7, C8	Cap, plstc, 0.47 uF ±10%, 250V	184366	56289	C280AE/A470K	2		
CR1 thru CR4	Diode, Si, 1 amp, 600 piv	112383	05277	1N4822	4		
CR5 thru CR8	Diode, zener	328820	04713	1N3040B	4		
Q1, Q4	Xstr, Si, NPN (located on Heatsink)	223602	05277	2N3773	2		
Q2	Xstr, Si, NPN	218511	95303	65120	1		
Q3	Xstr, Si, PNP	276899	95303	2N5415	1		
R1	Res, comp, 4.7k ±5%, ½W	108886	01121	EB4725	1		
R2, R3	Res, comp, 33k ±10%, 2W	158964	01121	HB3331	2		
R4, R6	Res, comp, 8.2k ±5%, 1S	330936	01121	GB8225	2		
R5	Not used						
R7, R8	Res, comp, 6.8k ±5%, ½W	187906	01121	EB6825	2		
R9	Res, comp, 51 ±5%, ½W	144717	01121	EB5105	1		
S1, S2	Switch, slide, dpdt	234278	82389	XW1649	2		
	Conn, recpt, amp	267534	00779	85884-3	6		
	Conn, Post	267500	00779	86144-2	8		
	Heatsink (use with Q2, Q3)	104646	05820	207-AB	2		
	Heatsink	334524	89536	334524	1		
	Socket, Xstr	342816	91506	X8080-1G10	2		
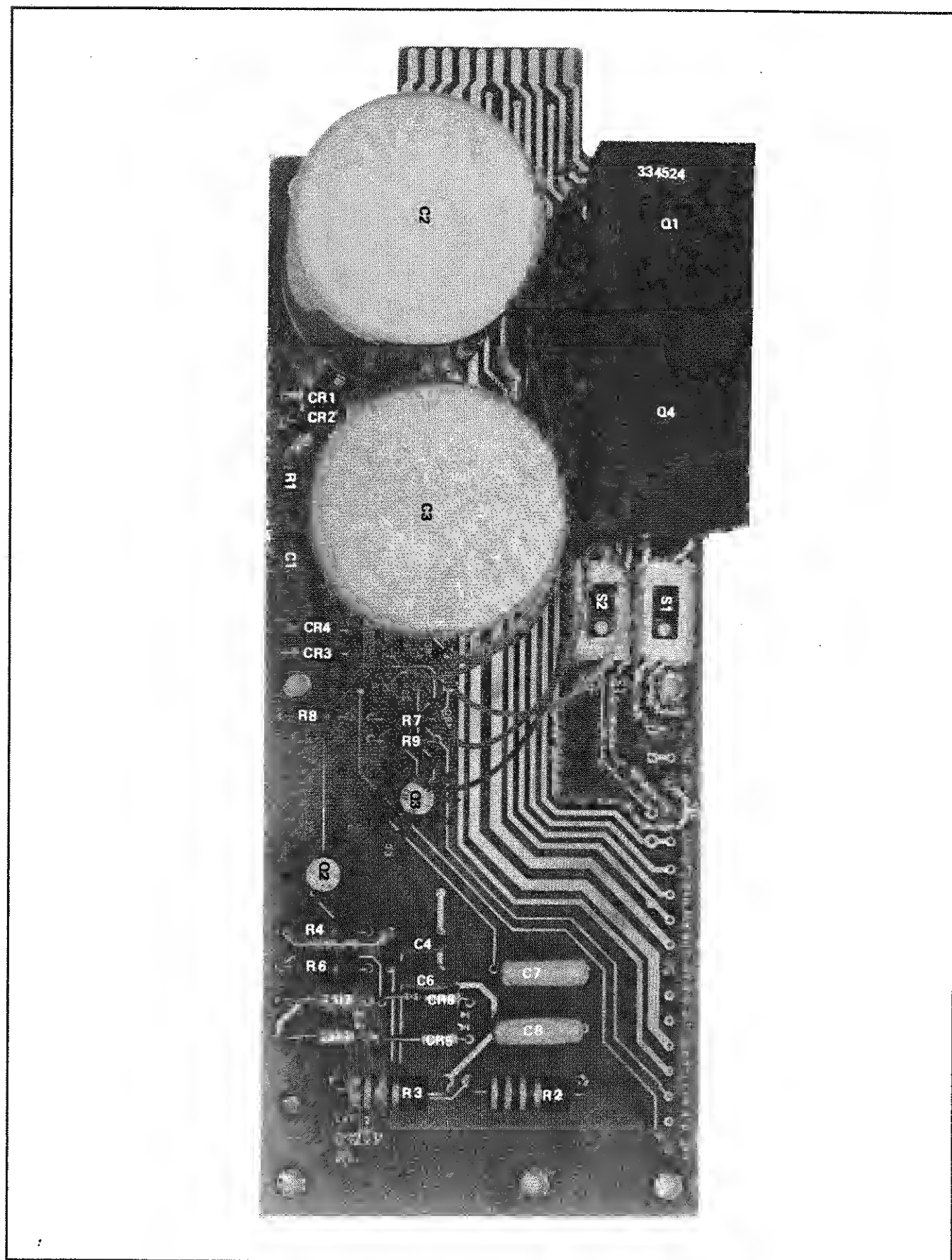
Figure 5-11. H. V. POWER SUPPLY AND CONNECTOR BOARD

Section 6
Option & Accessory Information

6-1. INTRODUCTION

6-2.   This section of the manual contains information pertaining to the accessories and options available for your instrument.

6-3. OPTION INFORMATION

6-4.   Each of the options available for this instrument, if any, are described separately under headings containing the option number. The option descriptions contain applicable operating and maintenance instructions and field installation procedures. A complete list of replaceable parts for each option is contained at the end of that option description.

6-5. ACCESSORY INFORMATION

6-6.   The accessory information, if applicable, will contain details concerning accessories that may be used with this particular instrument.

Option—07
100μV Resolution

6-1. INTRODUCTION

6-2. The —07 Option provides 100μV resolution (E Decade) throughout the voltage range of 0 to 16.6665V dc in the Model 4210A. Status of the E decade is not provided on the front panel display.

6-3. SPECIFICATIONS

6-4. Specifications for the —07 Option are located in Section 1 of the manual.

6-5. INSTALLATION

6-6. Use the following procedure to install the —07 Option into the Model 4210A.

a. Disconnect the power cord from line power.

b. Remove the top dust cover and the inner guard cover.

c. Remove the A5 BCD LADDER ASSY by using a gentle rocking motion and an even, rearward pulling force.

d. Remove four mounting screws on rear panel adjacent to Programming Connector, J1.

e. Insert the —07 Option, A5 BCD Ladder into LADDER receptacle (J2) on MOTHER ASSY.

f. Attach Programming Connector J1 panel to rear panel of instrument using the four screws removed in step d.

g. Replace inner guard and top dust cover.

h. Reconnect power cord to line power.

6-7. OPERATING INSTRUCTIONS

6-8. Programming Information

6-9. Operation of the 4210A with the —07 Option is done in a manner similar to operation with the —01 Option, Isolated Control Logic, described in Section 2. Programming input/output lines for the Programming Connector are given in Table 6-1.

Table 6-1. PROGRAMMING INPUT/OUTPUTS

PIN NO.	FUNCTION	
	LOGIC "0" = 2.8 to +5.5Vdc or open circuit	
	LOGIC "1" = 0 ±0.4Vdc or short circuit to LOGIC GRD.	
	CODE	
1	8	
2	4	A OECAOE (1V)
3	2	
4	1	
5	8	
6	4	8 OECAOE (0.1V)
7	2	
8	1	
9	8	
10	4	C DECADE (0.01V)
11	2	
12	1	
13	8	
14	4	D DECADE (0.001V)
15	2	
16	1	
43	8	
44	4	E OECADE (0.0001V)
45	2	
46	1	
17		
18		
20		
21	LOGIC GRD	
22		
23		
24		
25	LOGIC PWR (+5 vdc at 0 to 125mA)	
26		
27		
28		
29	NOT USED	
30		
31		
32		
33	DATA STROBE (—01 Option) (See Figure 2-6) INITIATES DIGITAL TO ANALOG CONVERSION	
34	STANDBY/OPERATE: LOGIC "0" = OPERATE LOGIC "1" = STANDBY	
35	SIGN: LOGIC "0" = POSITIVE OUTPUT LOGIC "1" = NEGATIVE OUTPUT	
36	EXTERNAL REFERENCE (—03 Option): LOGIC "0" = INTERNAL REFERENCE LOGIC "1" = EXTERNAL REFERENCE	
37	READY/NOT READY FLAG: LOGIC "0" = READY LOGIC "1" = NOT READY	
38		
39		
40	NOT USED	
41		
42		
47		
48		
49	CURRENT OVERLOAD FLAG: LOGIC "0" = NORMAL LOGIC "1" = OVERLOAD	
50	NOT USED	

6-10. Manual Operation

6-11. Operation of the 4210A—07 with the Accessory A4200 is done as follows:

a. Ensure that all push buttons on the A4200 are in the non-depressed condition.

b. Attach mating connector on A4200 cable to Programming Connector (J1) on rear of Model 4210A —07.

c. To obtain E decade output voltage ranging from 100 to 1500μV, depress CURRENT LIMIT MA press-buttons *10, 20, 40,* and *80* sequentially. The STROBE push-button must be depressed following each of the above. Depression of a current limit button followed by a STROBE calls an output voltage in microvolts that is ten times the button legend (s). A second depression followed by a STROBE removes the call.

6-12. THEORY OF OPERATION

6-13. General

6-14. A5 BCD Ladder (4210A-1032)

6-15. The A5 BCD Ladder contains a buffer amplifier for V_{REF} and the four lower decade segments of a ladder network. The buffer amplifier produces a V_R' signal from V_{REF} to prevent loading of V_{REF} by ladder switching currents. The ladder decades are voltage dividers weighted in fifteenths for control by digital words from 0 to 15 (8 + 4 + 2 + 1). The relative position of each decade with respect to the ladder output determines the significance of each decade's contribution to the total ladder network output.

6-16. BUFFER AMPLIFIER. The Buffer Amplifier composed of Q1 through Q3 is a unity gain amplifier connected through CR1 to function as a voltage follower. This circuit produces a V_R' signal that is applied to the ladder driver circuits. Output impedance is sufficiently low from dc to 100 kHz to prevent loading by ladder switching currents.

6-17. LADDERS. The four lower decade ladders consist of R1 through R18 and R119 through R12. Each decade of the ladder is formed essentially by four resistors which, in combination, weight the division factor of each decade in fifteenths. A simplified diagram of a typical decade ladder is shown in Figure 6-1.
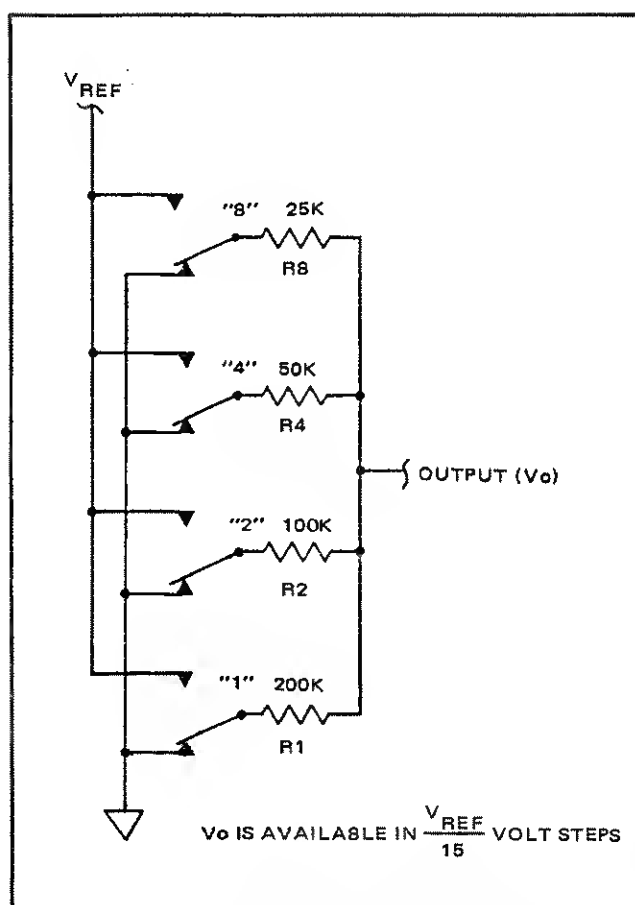
Figure 6-1. LADDER DECADE (SIMPLIFIED)

Inside figure: V_{REF}; "8" 25K R8; "4" 50K R4; OUTPUT (V_0); "2" 100K R2; "1" 200K R1; Vo IS AVAILABLE IN $\frac{V_{REF}}{15}$ VOLT STEPS

Table 6-3. RESOLUTION CHECK

STEPS	DECADE E	OUTPUT VOLTAGE (μV)
1	0	0 ±100 (Record voltage)
2	1	100μV > Step 1 Voltage
3	2	200μV > Step 1 Voltage
4	4	400μV > Step 1 Voltage
5	8	800μV > Step 1 Voltage

6-18. MAINTENANCE PROCEDURES

6-19. Maintenance procedures for the Model 4210A—07 are the same as those given in Section 4 of the manual. A resolution check of the —07 Option is given in the following paragraphs.

6-20. This procedure provides a resolution check on the E decade. Required equipment is a FLUKE Model 8400A —01 AC/DC Voltmeter, or equivalent, and a FLUKE Model A4200 Manual Control Unit (MCU).

a. Connect Model A4200 MCU as described in steps 6-11., a. and b.

b. Connect Model 8400A—01 Voltmeter to ±OUTPUT TERMINALS of barrier strip on rear of Model 4210A—07.

c. With all decades set to zero, perform steps 1 through 5 in Table 6-3. Each push-button on the A4200 MCU must be released for each succeeding step following step 2. Each step also must be followed by a STROBE.

6-21. LIST OF REPLACEABLE PARTS

6-22. For column entry explanations, part ordering information and basic instrument configuration Use Codes and Serial Number Effectivity List, see Section 5, paragraphs 5-1 through 5-10. See paragraph 6-40, this option subsection, for additional Use Codes and Serial Number Effectivity List assigned to this printed circuit assembly option.

6-23. SERIAL NUMBER EFFECTIVITY

6-24. A Use Code column is provided to identify certain parts that have been added, deleted, or modified during production of the Model 4210A. Each part in this option for which a use code has been assigned may be identified with a particular serial number by consulting the Use Code Effectivity List below. All parts with no code are used on all serial numbers 123 and on. NOTE: These Use Codes and Serial Number Effectivity apply to this option only. For the standard instrument configuration, see Section 5, paragraph 5-9, and for additional options, see the appropriate option subsection.

USE
CODE   SERIAL NUMBER EFFECTIVITY

REF DES	DESCRIPTION	SNO	TOT QTY	RECM QTY	USE CODE
A5	**BCD LADDER PCB ASSEMBLY —07 Option** **FIGURE 6-2.**	322602	REF		
C1, C2	Cap, cer, 0.05 uF ±20%, 100V	149161	2		
CR1	Dio, silicon, 150 mA	203323	1		
Q1	Dio, FET, current regulator	285106	1		
Q2	Xstr, silicon, NPN	269084	1		
Q7, Q11, Q15, Q19, Q23, Q27, Q31, Q35, Q39, Q43, Q47, Q51, Q55, Q59, Q63, Q67	Xstr, silicon, NPN	218396	16		
Q3	Xstr, silicon, PNP	269076	1		
Q4	Not used				
Q5, Q9, Q13 Q17, Q21, Q25, Q29, Q33, Q37, Q41, Q45, Q49, Q53, Q57, Q61, Q65	Xstr, silicon, PNP	195974	16		
Q6, Q8	Xstr, J-FET, N-channel, U2366E, Matched Pair	306399	1		
Q10, Q12	Xstr, J-FET, N-channel, U2366E, Matched Pair	306381	1		
Q14, Q16, Q18, Q20	Xstr, J-FET N-channel, U2366e, Matched Pairs (Q14 matched to Q16; Q18 matched to Q20)	306373	2		
Q22, Q24, Q26, Q28, Q30, Q32, Q34, Q36, Q46, Q48, Q50, Q52	Xstr, J-FET, N-channel, U2366E, Matched Set	298299	1		
Q38, Q40, Q42, Q44, Q54, Q56, Q58, Q60, Q62, Q64, Q66, Q68	Xstr, J-FET, N-channel	288324	12		
R1	Res, var, cermet, 200Ω ±10%, 1/2w	285148	1		
R2	Res, ww, 24.987k				
R3	Res, ww, 49.975k Matched Resistor Set	289827	1		
R5	Res, ww, 100.025k				

Figure 6-2. BCD LADDER PCB ASSEMBLY

REF DES	DESCRIPTION	SNO	TOT QTY	RECM QTY	USE CODE
R6	Res, ww, 200.075k ⎫				
R7	Res, ww, 108k ⎬ Matched Resistor Set	289827	1		
R4	Res, var, cermet, 50Ω ±10%, 1/2w	285122	1		
R8	Res, met flm, 60.4Ω ±1%, 1/8w	235366	1		
R9	Res, ww, 24.987k ±0.03%, 1/4w	289769	1		
R10	Res, ww, 50k ±0.03%, 1/4w	289777	1		
R11	Res, met flm, 100.03k ±0.1%, 1/8w	291088	1		
R12	Res, met flm, 200.08k ±0.1%, 1/8w	290122	1		
R13, R18	Res, met flm, 108.06k ±0.1%, 1/8w	290114	2		
R14, R120	Res, met flm, 49.9k ±0.1%, 1/8w	291070	2		
R15, R119	Res, met flm, 24.9k ±0.1%, 1/8w	290106	2		
R16, R121	Res, met flm, 100k ±0.5%, 1/8w	291054	2		
R17, R122	Res, met flm, 200k ±1%, 1/8w	261701	2		
R19	Res, cmpsn, 1.8k ±5%, 1/4w	175042	1		
R24, R30, R36, R42, R48, R54, R60, R66, R72, R78, R84, R90, R96, R102, R108, R114	Res, cmpsn, 560Ω ±5%, 1/4w	147991	16		
R20	Res, cmpsn, 20k ±5%, 1/4w	221614	1		
R25, R27, R28, R31, R33, R34, R37, R39, R40, R43, R45, R46, R49, R51, R52, R55, R57, R58, R61, R63, R64, R67, R69, R70, R73, R75, R76, R79, R81, R82, R85, R87, R88, R91, R93, R94, R97, R99,	Res, cmpsn, 51k ±5%, 1/4w	193334	48		

REF DES	DESCRIPTION	SNO	TOT QTY	RECM QTY	USE CODE
R100, R103, R105, R106, R109, R111, R112, R115, R117, R118	Res, cmpsn, 51k ±5%, 1/4w	193334	48		
R21, R22	Not used				
R23, R26, R29, R32, R35, R38, R41, R44, R47, R50, R53, R56, R59, R62, R65, R68, R71, R74, R77, R80, R83, R86, R89, R92, R95, R98, R101, R104, R107, R110, R113, R116	Res, cmpsn, 2.7k ±5%, 1/4w	170720	32		
R123	Res, met flm, 120k ±1%, 1/8w	291062	1		
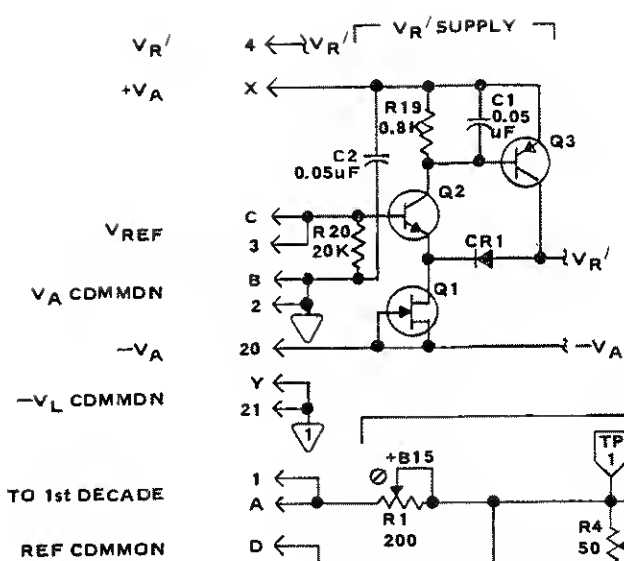
DRIVER DESIG.	CKT. CKT
RA	2.7K
RB	560
RC	51K
RD	2.7K
RE	51K/100K
RF	
QA	2N3906
Qb	U2366E/U1994E
QC	2N3904
QD	U2366E/U1994E

$V_R{}'$ 4 ← $V_R{}'$
$+V_A$ X ←

$V_R{}'$ SUPPLY

R19 0.8K C1 0.05 uF Q3
C2 0.05uF Q2
V_{REF} C 3 ← R20 20K CR1 $V_R{}'$
V_A COMMON B 2 ← Q1
$-V_A$ 20 ← $-V_A$
$-V_L$ COMMON Y 21 ←

LADDER

+B15
TP 1
TO 1st DECADE 1 ← A ← R1 200 R4 50 R7 108K R8 60.4 R13 108.0
REF COMMON D ←
R2 24.987K R3 49.975K R5 100.025K R6 200.075K R9 24.987K R10 50K R11 100.03K R12 200.08

DRIVER D28 | DRIVER D24 | DRIVER D22 | DRIVER D21 | DRIVER D33 | DRIVER D34 | DRIVER D32 | DRIVER D31

5 B8 | R B4 | P B2 | N B1 | W C8 | V C4 | U C2 | T C1

B DECADE C DECADE

DRIVER (16 PLACES)
$V_R{}'$
RE
QA RB RC Q
RA RD

LOGIC BIT INPUT
(DV = TRUE)

Option -09
Multi-Strobe Isolated Logic

609-1. INTRODUCTION

609-2. Multi-Strobe Isolated Logic, Option -09 for the Fluke 4200 Series Programmable Voltage Sources, provides voltage source remote control capability. A computer, a system controller or the Fluke Automatic Test Equipment System can control Programmable Voltage Sources equipped with the Multi-Strobe Isolated Logic Option.

609-3. The 4200-09 Option comprises two printed circuit boards mounted as one assembly within a 4200 Series Voltage Source. Physical access to the 4200-09 is through an opening in the 4200 chassis rear panel; electrical access is through a 50-pin connector.

609-4. Program source to 4200-09 connection is through a cable from the selected program source to the 4200-09 50-pin connector. (Refer to Figure 609-1.) The interconnecting cable connector is an Amphenol Blue Ribbon 57-30500, Fluke Stock Number 266056. The program source cable connector and cable wiring configuration is determined by the program source in use. An additional 56-pin card edge connector on the 4200-09 rear panel provides single program source control of up to eight 4200-09 units. Additional 4200-09 units are connected in a series configuration as shown in Figure 609-2.

609-5. Program Source Requirements

609-6. Fluke 4200 Series Programmable Voltage Sources require either BCD or Binary coded input commands; the 4200-09 Option will operate with either coding format. Source program data must include the following information:

1. Output voltage magnitude.

2. Output voltage range.

3. Output voltage polarity.

4. Current limit magnitude and range. (Option).

5. Strobe pulse(s).

6. Voltage Source mainframe address.

7. Operate/Standby signal.

8. External/Internal Reference Signal. (Option).

609-7. In addition to providing program information to the voltage source, the program source should be capable of receiving status information from the voltage source. Through unique voltage source mainframe address, the program source can determine the status of any voltage source in a multiple source system. Status information supplied by the voltage source includes:

1. Current Limit condition (Polled).

2. Power Off condition (Polled).

3. Abnormal Status.

4. Ready/Not Ready Status.
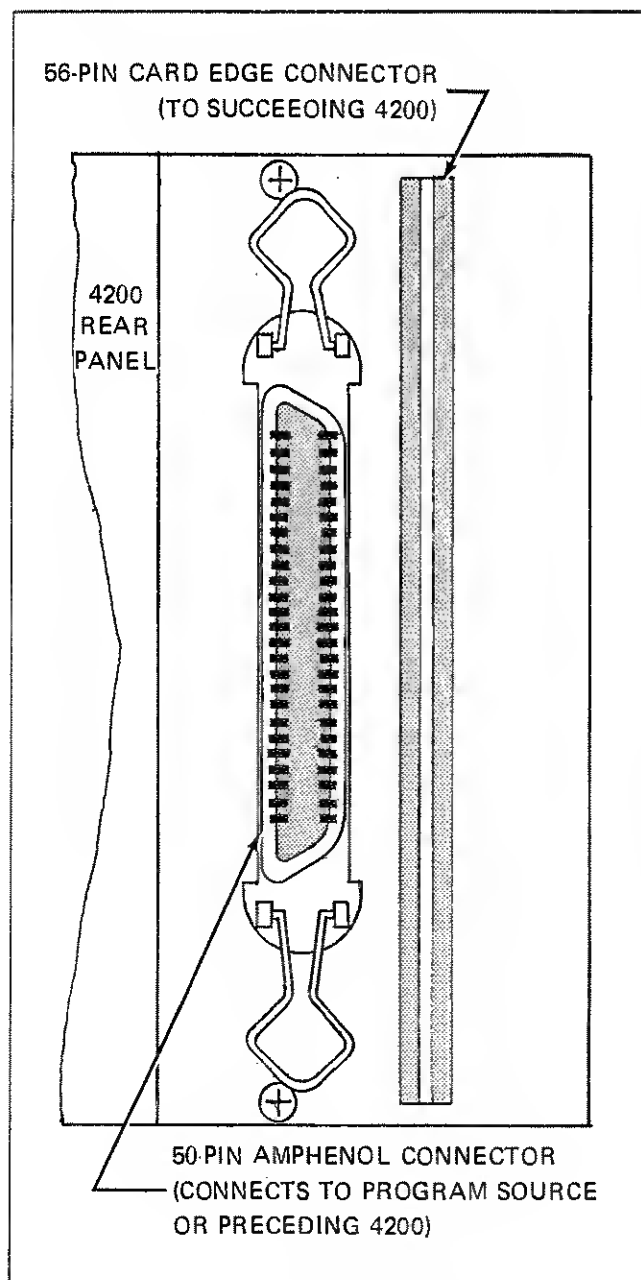
Figure 609-1. 4200-09 Connectors

609-8. OPERATING INSTRUCTIONS

609-9. Since a program source, not a human operator, controls the 4200-09 Multi-Strobe Isolated Logic, the following operating instructions define program data required for 4200-09 operation. Table 609-1 describes standard interface signals between the 4200-09 and a Binary format program source; Table 609-2, describes standard interface signals between the 4200-09 and a BCD format program source. Some program data variations are possible through jumper connection options to tailor the 4200-09 for operation with a specific program source. (Refer to Table 609-3 for Standard Jumper Assignments.)
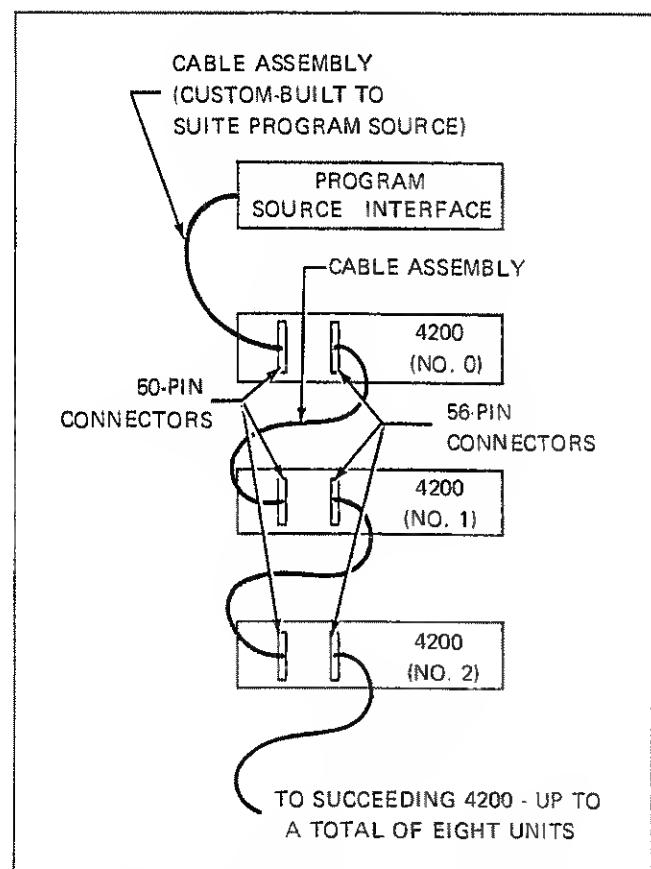
Figure 609-2. Multiple 4200 Connections

609-10. BINARY PROGRAM OPERATION

609-11. Binary Format

609-12. The standard Binary program data format for 4200-09 Voltage Sources consists of a 16-bit data word and a 16-bit control word. Refer to Figure 609-3. The control word can be less than 16-bits if less than eight voltage sources are programmed from one program source, or if the External Reference or Current Limit Options are not installed. Other Binary data formats are possible, but they require changing 4200-09 pcb jumper connections.

609-13. The first 14-bits of a 16-bit Binary data word contain voltage magnitude programming. The 15th bit is strobe control; the 16th bit is polarity programming. The first control word bit is standby/operate, and the second control word bit is output range programming. If the voltage source is equipped for external reference and selectable current limiting, six control word bits are required for those functions. The third control word bit would select the external reference mode; the fourth bit would select the current limit range. The remaining four bits would determine current limit magnitude. Eight remaining control word bits are address lines, used to select one voltage source in a multiple source system for programming.

Table 609-1. Input/Output Signals, Binary Program Source

PIN NUMBER		SIGNAL NAME	DESCRIPTION
50-PIN CONN.	56-PIN CONN.		(Logic 1 = 2.4V to 5.0V; Logic 0 = 0 to 0.4V)
42, 19, 44, 43, 24, 25 8, 3B, 10, 11, 40, 39, 14 & 12	P, R, S, T, K, L, M, N, E, F, H, J, A, B	Voltage output magnitude	Fourteen lines used to program the output voltage with a binary word. The least significant bit (pins 12 and B) is 2^0; the most significant bit (pins 42 and P) is 2^{13}. (Logic 1 = bit true; Logic 0 = bit false.)
13	D	Strobe Control	Single line used to steer the control strobe signal to transfer either the control word portion of the program data or the data portion of the program data. (Refer also to Single Strobe Operation.) Logic 1 transfers the control word; Logic 0 transfers the data word.
26	$\overline{\text{C}}$	Polarity (Sign)	Single line to program output polarity. Logic 1 for negative output; Logic 0 for positive output.
1	27	Output magnitude range	Single line to program output magnitude range on those voltage sources requiring range selection. (Logic 1 = high range; Logic 0 = low range.)
31	$\overline{\text{E}}$	External reference	Single line to program external reference mode on those voltage sources equipped with the external reference option. (Logic 1 = ext. reference; Logic 0 = int. reference.)
2	2B	Current limit range	Single line to program range of current output limiting on those voltage sources equipped current limit selection. (Logic 1 = 1 amp range; Logic 0 = 100 mA range.)
37, 35, 5 & 3	4, 3, 2, & 1	Current limit magnitude	Four lines to select the current limit value, expressed as a percentage of the programmed ranges. Up to 120% can be programmed. Any attempt to program 0% results in 10%. (Logic 1 = bit true; Logic 0 = bit false.)
17	U	Standby/Operate (address zero)	Single line used to select the standby or operate mode of the voltage source. Logic 1 programs Standby; Logic 0 programs operate.
23, 22, 34, 32, 7, 6, 4	V, W, X, Y, Z, $\overline{\text{A}}$,	Standby/Operate (addresses one through seven)	Seven lines (through connections) used to select the standby or operate mode of up to seven succeeding voltage sources.
20	12	Instrument mainframe (address zero)	Single line used to address the voltage source in order to perform any programming function. The addressing signal must be present in order for any strobe signal to be recognized by the 4200-09 logic. Logic 1 is address true; Logic 0 is address false.

Table 609-2. Input/Output Signals, Binary Program Source (cont)

PIN NUMBER		SIGNAL NAME	DESCRIPTION
50-PIN CONN.	**56-PIN CONN.**		(Logic 1 = 2.4 to 5V; Logic 0 = 0 to .4V)
21 & 45 thru 50	6 thru 11	Instrument mainframe address one through seven	Seven lines (through connections) used to address up to seven succeeding voltage sources.
18	13	Control Word Strobe	Single line which accepts a Logic 1, 1 μs or longer, pulse to load the control word or data word, depending on the state of the strobe control line. (See Sheet 1, pins D & 13.)
9	15	Poll status	Single line used to poll status (Vcc failure and current limit mode). A Logic 0 causes the generation of Vcc and current limit status at their respective outputs.
29	22	Polled current limit flag	Single line which generates a Logic 0 when the polled 4200 is in the current limit mode.
28	21	Polled power-off flag	Single line which generates a Logic 0 when the Vcc supply of the polled 4200 fails (power off).
27	23	Abnormal status	Single line which generates a Logic 0 whenever a 4200 goes to the current limit mode or the Vcc supply fails (power off). This status line does not need to be polled.
30	24	Vcc	Single line which provides Vcc to the staus logic on the 4200-09. (This is necessary in order to obtain polled power-off status when power is off.) Current requirement is 2 mA per power source.
16	25	Ready flag	Single line which provides a Logic 0 for a fixed time period after receipt of a strobe signal. The time period is equal to worst case settling time after the voltage source is programmed to a new output level.

NOTE

Current Limit, Power Off, Abnormal Status and Ready Flags require program source pull up resistors to reach Logic 1 state.

Table 609-2. Input/Output Signals, BCD Program Source

| PIN NUMBER | | SIGNAL NAME | DESCRIPTION |
50-PIN CONN.	56-PIN CONN.		(Logic 1 = 0 to 0.4V; Logic 0 = 2.4 to 5V)
43, 44, 19 & 42	T, S, R & P	Voltage output magnitude — MDS	Four BCD lines to program the most significant digit of the output voltage. (All 16 Magnitude Bits · Logic 1 = bit true; Logic 0 = bit false.)
38, B, 25 & 24	N, M, L & K	Voltage output magnitude — 2SD	Four BCD lines to program the second most significant digit of the output voltage.
39, 40, 11 & 10	J, H, F & E	Voltage output magnitude — 3SD	Four BCD lines to program the third most significant digit of the output voltage.
13, 15 12 & 14	D, C, B & A	Voltage output magnitude — LSD	Four BCD lines to program the least significant digit of the output voltage.
26	$\overline{C}$	Polarity (Sign)	Single line to program output polarity. Logic 1 programs negative output; Logic 0 programs positive output.
1	27	Output Magnitude range	Single line to program output magnitude range on those voltage sources requiring range selection. (Logic 1 = high range; Logic 0 = low range.)
31	$\overline{E}$	External reference	Single line to program external reference mode on those voltage sources equipped with the external reference option. (Logic 1 = ext. reference; Logic 0 = int. reference.)
2	2B	Current limit range	Single line to program range of current output limiting on those voltage sources equipped current limit selection. (Logic 1 = 1 amp range; Logic 0 = 100 mA range.)
37, 35, 5 & 3	4, 3 2 & 1	Current limit magnitude	Four lines to select the current limit value, expressed as a percentage of the programmed range. Up to 120% can be programmed. Any attempt to program 0% results in 10%. (Logic 1 = bit true; Logic 0 = bit false.)
17	U	Standby/Operate (address zero)	Single line used to select the standby or operate mode of the voltage source. Logic 1 programs standby; Logic 0 programs operate.
23, 22, 34, 32, 7, 6, & 4	V, W, X, Y, Z, $\overline{A}$,	Standby/Operate (addresses one through seven)	Seven lines (through connections) used to select the standby or operate mode of up to seven succeeding voltage sources.
20	12	Instrument mainframe (address zero)	Single line used to address the voltage source in order to perform any programming function. The addressing signal must be present in order for any strobe signal to be recognized by the 4200-09 logic. Addressing is by a Logic 1 on address line zero. Refer also to Addressing Multiple Mainframes.

Table 609-2. Input/Output Signals, BCD Program Source (cont)

PIN NUMBER		SIGNAL NAME	DESCRIPTION
50-PIN CONN.	56-PIN CONN.		
21 & 45 thru 50	6 thru 11	Instrument mainframe addresses one through seven	Seven lines (through connections) used to address up to seven succeeding voltage sources.
18	13	Control word strobe	Single line which accepts a Logic 1, 1 μs or longer, pulse to load the control word portion of the program data into the 4200-09 assembly. (Refer also to Dual-Strobe Operation.)
36	14	Data word strobe	Single line which accepts a Logic 1, 1 μs or longer, pulse to load the data word portion of the program data into the 4200-09 assembly. (Refer also to Dual-Strobe Operation.)
9	15	Poll status	Single line used to poll status (Vcc failure and current limit mode). A Logic 1 causes the generation of Vcc and current limit status of their respective outputs.
29	22	Polled current limit flag	Single line which generates a Logic 1 when the polled 4200 is in the current limit mode.
28	21	Polled power-off	Single line which generates a Logic 1 when the Vcc supply of the polled 4200 fails (power off).
27	23	Abnormal status	Single line which generates a Logic 1 whenever the 4200 goes to the current limit mode or the Vcc supply fails (power off). This status line does not need to be polled.
30	24	Vcc	Single line which provides Vcc to the status logic on the 4200-09. (This is necessary in order to obtain polled power-off status when power is off.) Current requirement is two milliamperes per power source.
16	25	Ready flag	Single line which provides a Logic 1 for a fixed time period after receipt of a strobe signal. The time period is equal to worst case settling time after the source is programmed to a new output level.

Table 609-3. Standard Jumper Configurations

4210A 4250A 4270A	4216A 4265A 4275A	4210A 4250A 4270A	4216A 4265A 4275A	4210A 4250A 4270A	4216A 4265A 4275A
B to E	A to B	V to W	W to Y	6 to 7	2 to 4
C to D	C to E	$\overline{A}$ to $\overline{B}$	$\overline{A}$ to $\overline{B}$	9 to 10	5 to 7
F to H	G to H	$\overline{E}$ to $\overline{F}$	$\overline{E}$ to $\overline{F}$	11 to 13	8 to 10
J to K	J to L	$\overline{G}$ to $\overline{H}$	$\overline{G}$ to $\overline{H}$	14 to 15	11 to 12
L to M	K to M	$\overline{L}$ to $\overline{M}$	$\overline{L}$ to $\overline{M}$	16 to 17	14 to 17
N to P	N to R	25 to 26	F to 27	18 to 20	16 to 19
S to T	T to U	1 to 4	26 to 28	22 to 23	

Figure 609-3. Binary Program Data, Standard Format

609-14. BINARY LOGIC SENSE

609-15. Data word logic sense, positive-true (true = 5V) or negative-true (true = 0V), is determined by jumper connections between pads J, K, L, M, W, X, and Y. Standard operation uses positive-true logic, and it is achieved through jumpering W to Y, J to L, and M to K. Negative-true data word logic may be established by jumpering W to X, J to K, and M to L (refer to Figure 609-4).

609-16. Control word logic sense may also be either positive-true or negative-true, with positive-true being the standard operating logic sense. To establish positive-true control word logic, jumper pad N to pad R; to establish negative-true logic, jumper pad N to pad P. (Refer to Figure 609-4.)

609-17. BINARY VOLTAGE SOURCE POLARITY

609-18. Voltage source output polarity, either positive or negative, is selected by a polarity bit in the 16-bit Binary data word. Bit-16 in the data word is polarity selection (refer to Figure 609-3). It is possible to establish polarity using the first bit of the control word by jumpering pad 16 to pad 17 and pad B to pad E. However, if the first control word bit is used for polarity, asynchronous standby/operate programming must be established by jumpering pad 20 to either pad 19 (standby = positive-true) or pad 18 (operate = positive-true). Pad D must be jumpered to pad C for either logic sense. (Refer to Figure 609-4.)

Figure 609-4. 4200-09 Jumper Connections

J. BCD/BINARY DUAL STROBE

K. BINARY SINGLE STROBE; STROBE CONTROL POSITIVE—TRUE TO LOAD CONTROL WORD

L. BINARY SINGLE STROBE; STROBE CONTROL POSITIVE—TRUE TO LOAD DATA WORD

M. CONTROL WORD STROBE BIT POSITIVE—TRUE

N. CONTROL WORD STROBE BIT NEGATIVE—TRUE

O. DATA WORD STROBE BIT POSITIVE—TRUE

P. DATA WORD STROBE NEGATIVE—TRUE

Q. MAINFRAME ADDRESS POSITIVE—TRUE

Figure 609-4. 4200-09 Jumper Connections (cont)

R. **MAINFRAME ADDRESS NEGATIVE–TRUE**

S. **BINARY 16-BIT DATA WORD; LAST BIT NOT COMPLEMENTED**

T. **BINARY 16-BIT DATA WORD; COMPLEMENT ALL 16 BITS**

U. **DATA WORD INITIATES DATA TRANSFER ACROSS GUARD**

V. **DATA WORD DOES NOT INITIATE TRANSFER ACROSS GUARD**

W. **CONTROL WORD INITIATES DATA TRANSFER ACROSS GUARD**

X. **CONTROL WORD DOES NOT INITIATE DATA TRANSFER ACROSS GUARD**

Y. **NOT READY FLAG FIXED TIME DURATION**

Figure 609-4. 4200-09 Jumper Connections (cont)
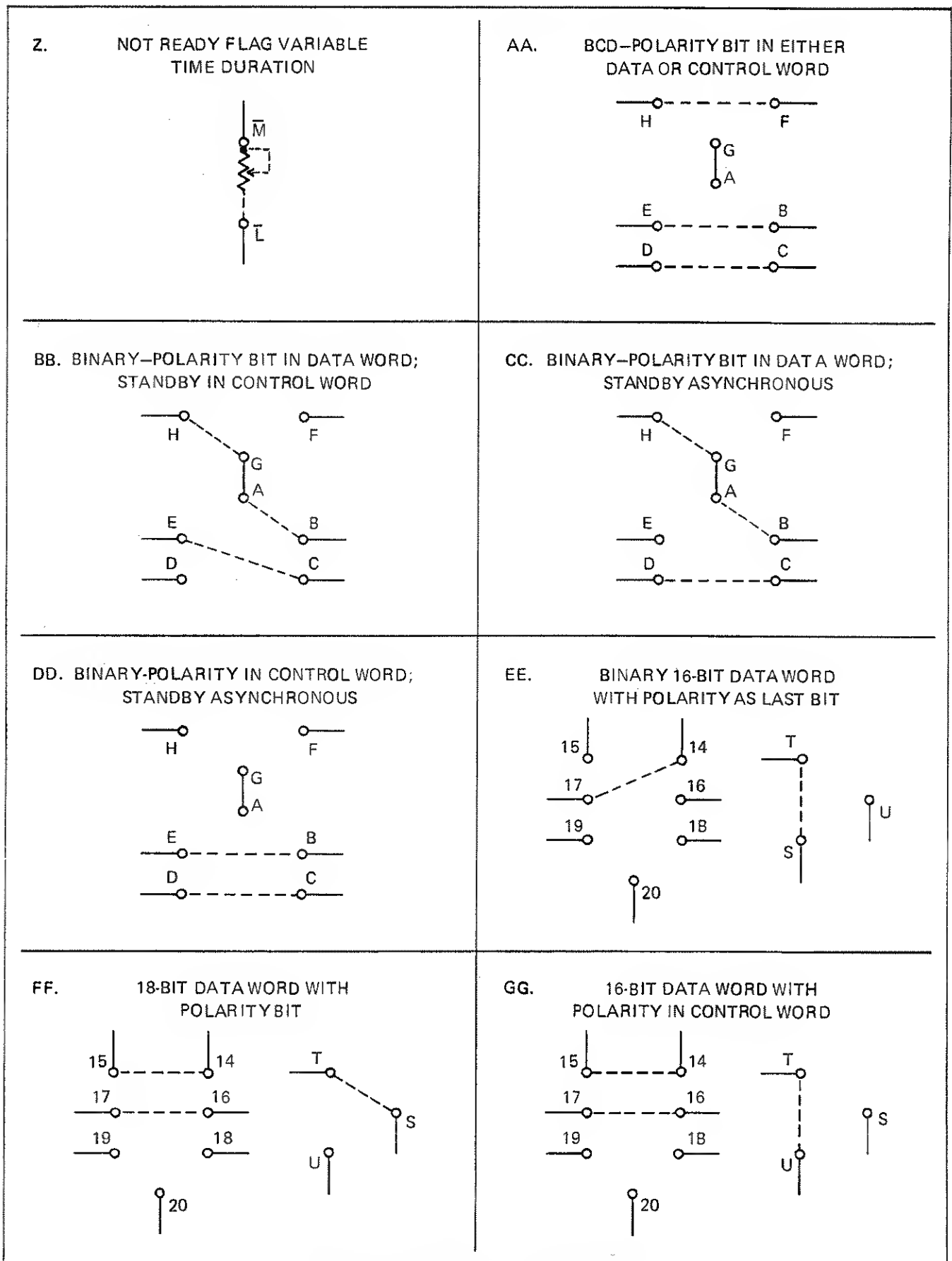
Figure 609-4. 4200-09 Jumper Connections (cont)

HH. STAND8Y/OPERATE SYNCHRONOUS; CONTROL WORD=POSITIVE–TRUE STAND8Y = POSITIVE – TRUE
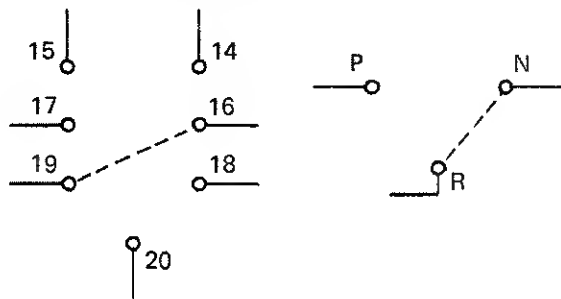
JJ. STAND8Y/OPERATE SYNCHRONOUS; CONTROL WORD=POSITIVE–TRUE OPERATE = POSITIVE – TRUE
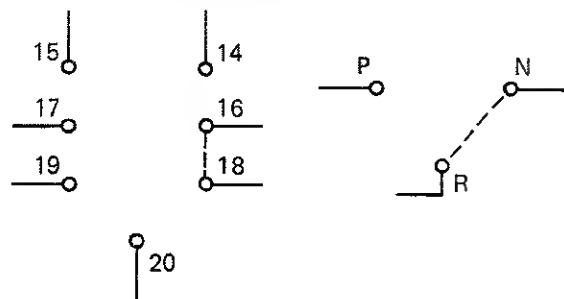
KK. STAND8Y/OPERATE SYNCHRONOUS CONTROL WORD=NEGATIVE–TRUE STANDBY=POSITIVE–TRUE
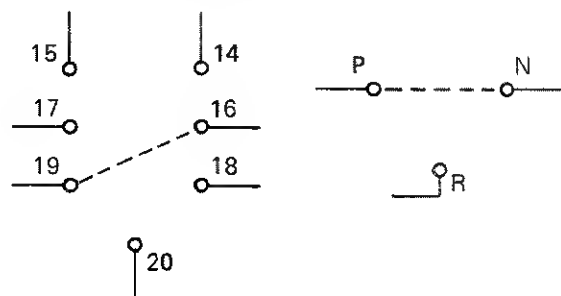
LL. STAND8Y/OPERATE SYNCHRONOUS CONTROL WORD=NEGATIVE–TRUE OPERATE=POSITIVE–TRUE
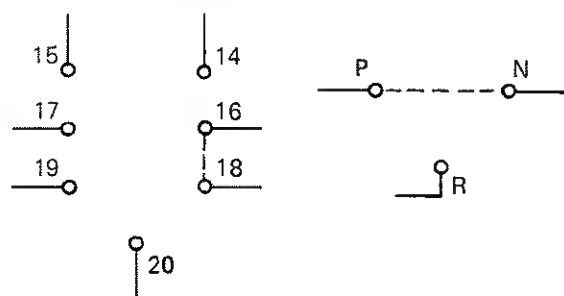
MM. STAND8Y/OPERATE ASYNCHRONOUS; STANDBY = POSITIVE – TRUE
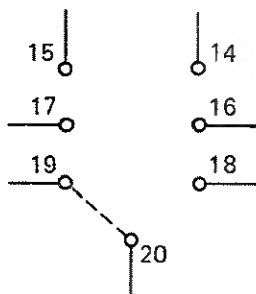
NN. STANDBY/OPERATE ASYNCHRONOUS; OPERATE = POSITIVE – TRUE
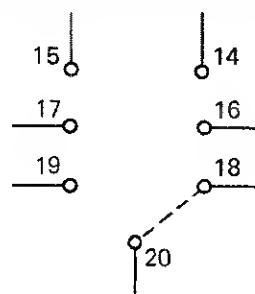
OO. 4275A–09 STANDARD 8INARY
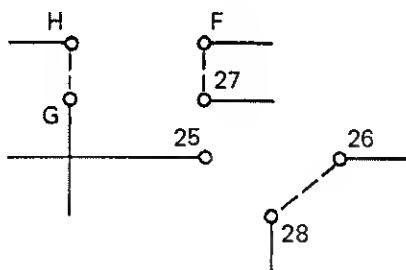
PP. 4275A POLARITY IN CONTROL WORD
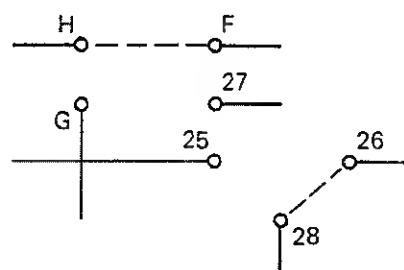
Figure 609-4. 4200-09 Jumper Connections (cont)

609-19. BINARY PROGRAM DATA COMPLEMENTING

609-20.   Binary data words representing negative voltage outputs are two's complemented and must be recomplemented by the 4200-09 circuitry to obtain the required power source output polarity. When jumpering is performed to receive Binary data from the program source (pads, J, K, L, M, W, X and Y), complementing to accomplish this is automatically performed. Since the complementing process must not complement the polarity bit, one additional jumper is required to assure this.

609-21.   The polarity bit may be either the last (16th) bit in the data word or the first bit in the control word. If it is the last bit in the data word, as shown in Figure 609-3, jumper pad $\overline{A}$ to pad $\overline{B}$. If polarity is indicated by a bit within the control word, the entire data word can be complemented. Jumper pad $\overline{A}$ to pad $\overline{C}$ to accomplish this.

609-22.   When used in a 4275A Voltage Source, the standard 4200-09 Option jumper configuration includes pad F to pad 27, pad G to pad H and pad 26 to pad 28. The standard Binary data format may be used, but the two 4275A least significant bits of magnitude (the "1" bit and ".5" bit) will not be programmed. Only 14 magnitude bits will be programmed, with the polarity programming in place of the "1" bit and the ".5" bit unprogrammable. An optional jumper configuration is possible if the polarity bit is placed in the control word. By jumpering pad H to pad F and removing the jumpers between pads H and G

and between pads F and 27, the 4275A "1" bit may be programmed. No jumper configuration will allow the ".5" bit to be programmed.

609-23.   BCD Program Operation

609-24.   BCD FORMAT

609-25.   The standard program data format for BCD-type 4200 Voltage Sources consists of an 18-bit data word and a control word of 6-bits (refer to Figure 609-5). In the standard BCD format, the first four data bits program the most significant digit (MSD) of output magnitude; bits 5 through 8 program the second significant digit (2SD); bits 9 through 12 program the third significant digit (3SD); bits 13 through 16 program the least significant digit (LSD). Bit 17 programs the polarity, and bit 18 programs output range. The first control word data bit programs the external reference mode if the voltage source is equipped with the external reference option. The second control word data bit programs the current output limit range for those voltage sources equipped with current limit selection; control word bits 3 through 6 program the current limit magnitude. The advantage of the 18-bit data word is that it keeps the BCD output magnitude commands separate from the control commands. Output magnitude programming can thus be changed without effecting previously programmed control data. Also, if there is no current limit or external reference to be programmed, only one data word is necessary to control the voltage source. To obtain an 18-bit data word and 6-bit control word, the board comes with a jumper from pad T to pad S. (Refer to Figure 609-4.)
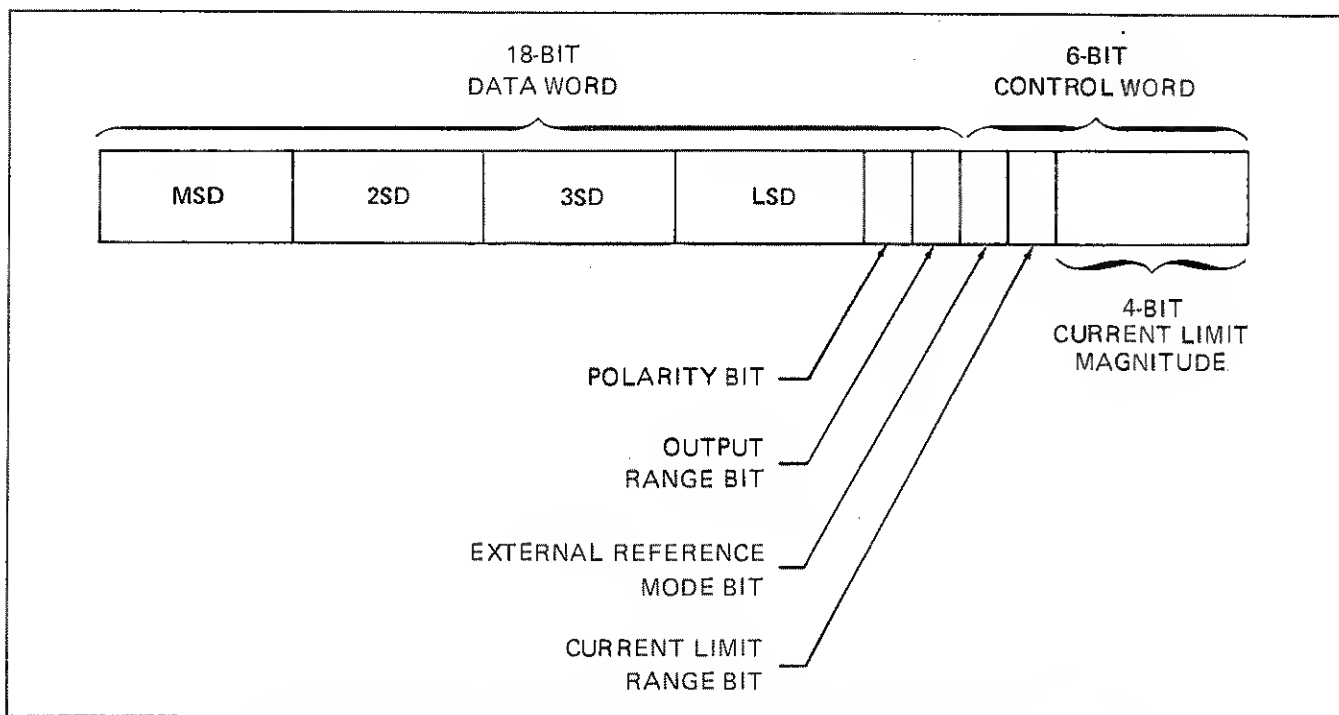
Figure 609-5. BCD Program Data, Typical 18-Bit Data Word, 6-Bit Control Word

609-26. A mainframe address bit for each voltage source being addressed is also required, but the address bits are not part of either the data word or control word. The address bit must be true for the source being addressed during both data word and control word loading. In the standard BCD format (18-bit data word and 6-bit control word) the standby/operate bit is not part of either word. Instead, a bit must be supplied for each voltage source because the jumpers are configured for asynchronous standby/operate transfer. Synchronous transfer is possible in the standard format, but polarity control must be sacrificed. (Refer to Figure 609-6.)

609-27. An optional BCD format using a 16-bit data word and an 8-bit control word is possible (refer to Figure 609-6). The data word consists of the 16-bits of BCD magnitude programming. The first control word bit is polarity (or standby/operate); the second bit selects the output range; the third bit is the external reference command; the fourth bit is the current limit range; and the fifth through eighth bits are current limit magnitudes. This format is obtained by jumpering pad T to pad U.

609-28. BCD LOGIC SENSE

609-29. Both the BCD data word and control word may be either positive-true logic or negative-true logic. Data word (16 or 18-bits) logic sense is determined by jumpering between pads J, K, L, M, V and W. Pad V must be jumpered to pad W for either BCD logic sense. The standard configuration is negative-true logic achieved by jumpering pad J to K and pad L to M. If positive-true logic is desired, jumper pad J to pad L and pad K to pad M. Also jumper pad F to pad H.

609-30. BCD control word logic sense may be either positive-true or negative-true, as determined by jumpering at pads N, P and R. The standard configuration is negative-true logic, established by jumpering pad P to pad N. If positive-true logic is required, jumper pad N to pad R. (Figure 609-4.)

NOTE

Positive-true logic employs +5V for logic 1 and 0V for logic 0.

609-31. BCD VOLTAGE SOURCE POLARITY

609-32. Voltage source output polarity is selected by a polarity data bit. The polarity bit may be placed in either an 18-bit data word or an 8-bit control word, depending on the data word length as selected through jumpering pads S, T, and U. With pad T jumpered to pad U, the data word will contain 16-bits; the Polarity bit will be the first data bit in the 8-bit control word. In the standard configuration, pad T is jumpered to pad S, and the data word contains 18-bits, with the Polarity bit being bit 17. In either case, jumper pad B to pad E. (Refer to Figure 609-4 and 609-6.)
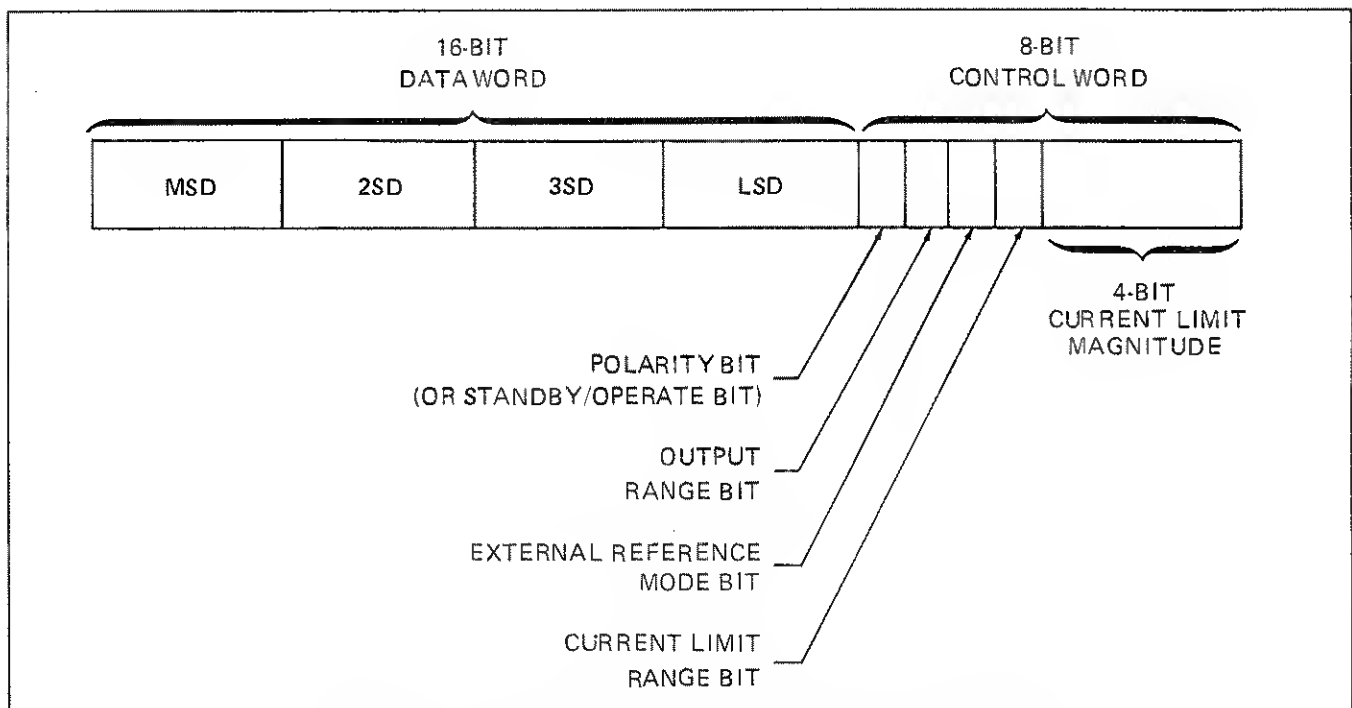
Figure 609-6. BCD Program Data, Typical 16-Bit and 8-Bit Data Words

609-33. Binary/BCD Program Operations

609-34. Program functions discussed in the following paragraphs apply to both BCD and Binary operation.

609-35. VOLTAGE SOURCE ADDRESSING

609-36. A 4200-09 Voltage Source receives program data only if it is addressed at the time it receives a strobe signal. The address signal may be either a high (+5V dc) or low 0V dc) logic level applied to address line number zero. Each Binary source, in the standard configuration, requires a positive-true address; each BCD source in the standard configuration, requires a negative-true address. For positive-true address levels, jumper pad 8 to pad 10. For negative-true address levels jumper pad 9 to pad 10.

609-37. A maximum of eight 4200-09 Voltage Sources may be individually addressed by one program source. Refer to Figure 609-2 for the multiple voltage source cable connection configuration. The voltage source electrically closest to the program source is numbered zero, and succeeding voltage sources are numbered consecutively one through seven. The program source supplies an address signal to each voltage source, for the duration of its programming sequence, on one of eight address lines (0-7).

609-38. Although the program source addresses the voltage sources on eight separate lines, each voltage source receives its address signal on address line zero. All eight program source addresses are applied to the address lines of the first voltage source, source number zero. Only address line zero supplies an address signal to the voltage source; all other addresses are shifted to the next lowest numerical address line (see Figure 609-7). The address signal originally issued on address line number one exits the first voltage source on address line number zero for use by the second voltage source. Each address signal is shifted by one address line position through each succeeding voltage source. Therefore, voltage source number seven (the eighth and last) receives only one address signal on the zero address line. Several voltage sources may be addressed at the same time, and each will receive the program data simultaneously. Table 609-4 lists the pin numbers of the 50-pin connector (on voltage source zero) used for addressing each voltage source in a multiple source system.

NOTE

In single-strobe Binary operation, the address need only be present when transferring the control word. When transferring the data word, the voltage source which last received a control word is automatically addressed.
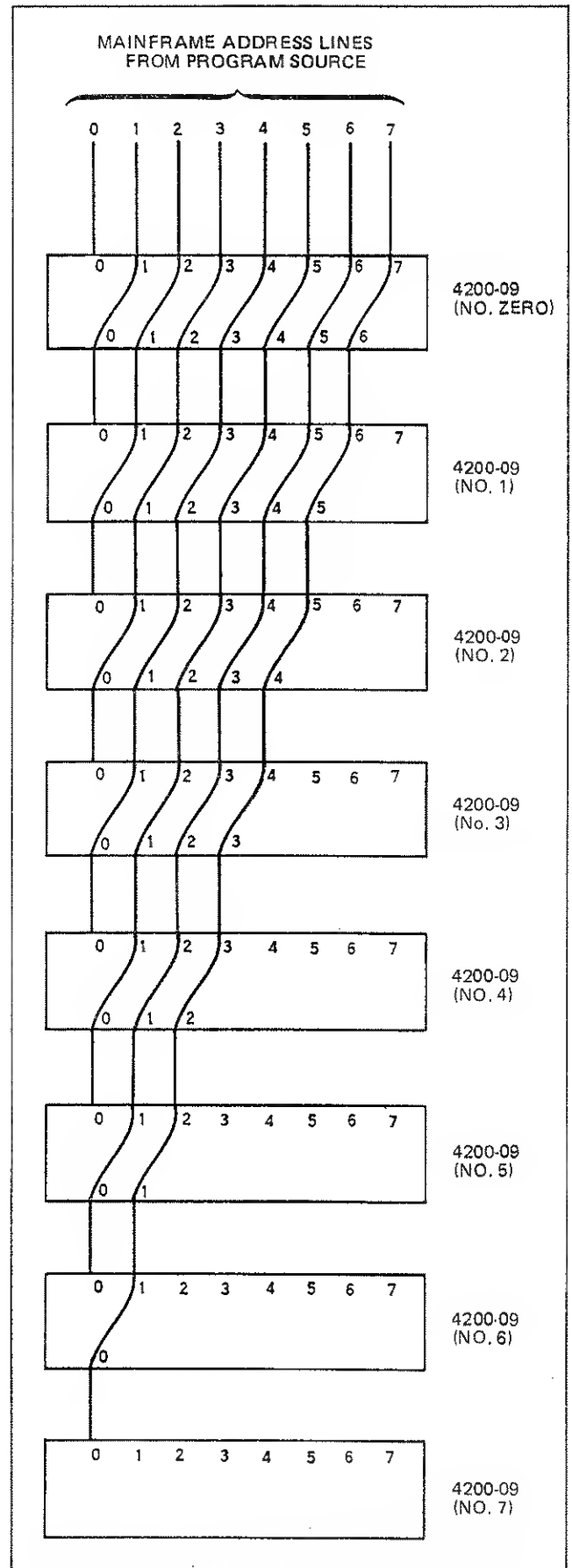
Figure 609-7. Multiple Mainframe Addressing

Table 609-4. Mainframe Addresses -
Pin Assignments

POWER SOURCE MAINFRAME ADDRESS	PIN NUMBER (50-pin connector on power source no. zero)
0	20
1	50
2	49
3	48
4	47
5	46
6	45
7	21

609-39. STANDBY/OPERATE - SYNCHRONOUS OR ASYNCHRONOUS

609-40. All 4200-09 Voltage Sources can be placed in either a Standby or Operate condition by the program source. Jumper configurations on the 4200-09 Option pcbs determine whether the Standby/Operate command is synchronous (transferred with the data or control word) or asynchronous (transferred independently). Asynchronous Standby/Operate commands are executed immediately upon receipt by the voltage source; synchronous commands are transferred and executed with the program data transfer (Strobe pulse).

609-41. In the standard Binary operating mode, the program source supplies Standby/Operate commands on one line. That line goes to all voltage sources at Standby/Operate zero (pin 17 of the 50-pin rear panel connector). Binary Standby/Operate commands are transferred synchronously. In the standard BCD operating mode, the program source must supply one Standby/Operate line per unit. All BCD Standby/Operate lines go to the first unit in a system and chain down from unit to unit exactly as the address lines do. BCD Standby/Operate lines transfer asynchronously, thus they must be latched and maintained in the desired state at all times.

609-42. Standard Binary configuration uses a positive-true control word and a positive-true Standby command (Standby = 5V, Operate = 0V). Positive-true Standby requires a jumper from pad 16 to pad 19. If a positive-true Operate command is required, jumper pad 16 to pad 18. However, if a negative-true control word is in use (pad N jumpered to pad P), then a positive Standby command requires a jumper from pad 16 to pad 18. Operate positive-true commands require a jumper from pad 16 to pad 19 with a negative-true control word.

609-43. Standard BCD configuration uses an asynchronous Standby/Operate command, so control word logic sense is irrelevant. Operate positive-true commands require a jumper from pad 18 to pad 20; Standby positive-true commands require a jumper from pad 19 to pad 20. Either Standby/Operate logic sense requires a jumper from pad C to pad D.

609-44. CONTROL AND DATA WORD STROBE SIGNALS

609-45. The 4200-09 can program output voltages in both Single Strobe and Dual Strobe modes. Standard Binary voltage source configurations operate in the Single Strobe mode. Standard BCD voltage source configurations operate in the Dual Strobe mode. Single Strobe operation employs one Strobe Pulse line, but two Strobe Pulses. The condition of the Strobe Control line (true or false) determines whether a Strobe Pulse loads the control word or the data word. Dual Strobe operation employs two Strobe Pulse lines and two Strobe Pulses, one to load the control word and one to load the data word.

609-46. Single strobe operation employs one Strobe Pulse Line and one Strobe Control Line to load both the data word and control word into the 4200-09 storage registers. A Binary control word is loaded into the registers by placing the required logic level on the strobe control line and placing a strobe pulse on the control word strobe line. A Binary data word is loaded into the registers by reversing the strobe control line logic level and supplying a second strobe pulse. In this manner, a single strobe line is used to load both the data and control words by changing the strobe control line logic level.

609-47. Single strobe operation is established by jumpering pads 2, 3, 4, 11, 12 and 13. The standard configuration, Strobe Control line high (5V) to transfer the control word and low (0V) to transfer the data word, requires jumpers from pad 2 to pad 4 and from pad 11 to pad 12. To reverse the Strobe control logic sense, jumper pad 3 to pad 4 and leave the jumper from pad 11 to pad 12 in place. (Refer to Figure 609-4.)

609-48. Dual strobe operation requires two Strobe Pulses on two separate Strobe Pulse lines to load the data word and control word into the 4200-09 registers. A pulse on the data word strobe line loads a 16- or 18-bit data word into the the storage registers; a pulse on the control word strobe line loads the 6- or 8-bit control word into the registers.

609-49. Jumpering pad 1 to 4 and pad 11 to 13 establishes dual strobe operation. The standard dual strobe BCD configuration requires a jumper from pad 22 to pad 23 for the negative-true (0V) data word strobe, and a jumper from pad 6 to pad 7 for the negative control word strobe pulse. For a positive (5V) data word strobe pulse, jumper pad 23 to pad 24; for a positive control word strobe pulse, jumper pad 5 to pad 7. (Refer to Figure 609-4.)

609-50. Data word and control word Strobe Pulses, in both the single and dual strobe modes, are 1 μs or longer in width. Data on all programming lines must be valid

prior to the leading edge of the pulse, and it must remain unchanged for 100 ns after the strobe pulse trailing edge. A data word strobe, in the dual strobe mode, is issued after data is applied to the parallel data word inputs of the 4200-09 assembly. It loads the data bits into the parallel storage registers. In the dual strobe mode, the control word strobe loads only the control word from the program source into the storage registers; in the single strobe mode, the control word strobe pulse loads the data word into the registers when the strobe control line is at one logic level, then it loads the control word into the registers when the strobe control line is at the opposite logic level.

609-51.   PROGRAM DATA TRANSFER

609-52.   A control word strobe or data word strobe, generated by the program source, loads program data into the 4200-09 storage registers. The data (data word and control word) is transferred in a bit by bit serial fashion across the guard shield to the voltage source digital to analog converter. This transfer is initiated by the control word strobe, data word strobe, or both, as determined by jumpering between pads $\overline{D}$, $\overline{E}$, $\overline{F}$, $\overline{G}$, $\overline{H}$ and $\overline{J}$. (Refer to Figure 609-4.) The voltage source does not respond to newly programmed data until the transfer is complete.

609-53.   For standard Binary or BCD configurations, entering either the data word or control word initiates a data transfer from the input shift registers to the voltage source. Standard jumpering is from pad $\overline{E}$ to pad $\overline{F}$ and from pad $\overline{G}$ to pad $\overline{H}$. If only the control word is to initiate a data transfer, jumper pad $\overline{G}$ to $\overline{H}$ and pad $\overline{D}$ to $\overline{E}$. If only the data word is to initiate data transfer, jumper pad $\overline{H}$ to pad $\overline{J}$ and pad $\overline{E}$ to pad $\overline{F}$.

NOTE

When either the data word or control word initiates a transfer, all data stored in the input shift registers is transferred. For example, if the transfer is initiated by a control word, then the previously entered data word is transferred along with the current control word.

609-54.   VOLTAGE SOURCE STATUS FLAGS

609-55.   Each 4200-09 provides four separate status indications to the program source. Each status indication (flag) uses a separate line, but corresponding status lines of all 4200-09 voltage sources within a multiple source system are bussed together. The status flags provided are:

    1.   Abnormal status (power off or current limit) flag.

    2.   Polled current limit flag.

    3.   Polled power off flag.

    4.   Not ready flag.

NOTE

All flag lines are wire-ORed to an open collector bus. Pull-up resistors are required in the program source for the flag lines to reach +5 volts.

609-56.   Voltage source status checking is usually programmed to allow an abnormal status flag to interrupt the program source. As a result of the interrupt, the program source polls each 4200-09 in the system while monitoring both the polled current limit flag bus and the polled power off flag bus. The not ready flag is not polled, but when present, it indicates that the voltage source has not had sufficient time to settle at a newly programmed voltage level.

609-57.   POLLED CURRENT LIMIT FLAG

609-58.   Pin 29 of the voltage source 50-pin connector is the polled current limit line. As shown in Figure 609-8, all current limit lines in a multiple source system are bussed, but each voltage source poll status line (pin 9) is separate. To poll a voltage source status, the voltage source poll status line is usually tied to the address line if the address is negative-true. The voltage source can then supply current limit information on the polled current limit line each time it receives an address signal. When the voltage source uses a positive address (Binary), each poll status line (pin 9) may be grounded and a separate status flag line supplied for each flag. When polled, the current limit flag bus responds with a +5V level if that voltage source is not in a current limit condition.

609-59.   POLLED POWER OFF FLAG

609-60.   A power off flag is available when a voltage source is polled, as is the current limit flag. When the program source polls the power source, the poll status line is placed at ground level, and the power off status flag responds with a ground level if power is off. The voltage source can only respond with a ground level, indicating the power off condition, if +5 volts is supplied to pin 40 of the 50-pin connector. The external +5 volts is required for circuit operation if an actual power off condition exists.

609-61.   INPUT LOADING

609-62.   Each input of each 4200-09 voltage source represents a single TTL input load. In a multiple source system, the power requirements for each input of the first voltage source, exept the address and standby/operate inputs, increases by a factor representing the number of sources in the system. In BCD voltage sources, standby/operate inputs are single TTL loads as are the address lines. In Binary voltage sources, only the address lines are single loads; the standby/operate input loads in a multiple source system increase by a factor representing the number of sources in the system.
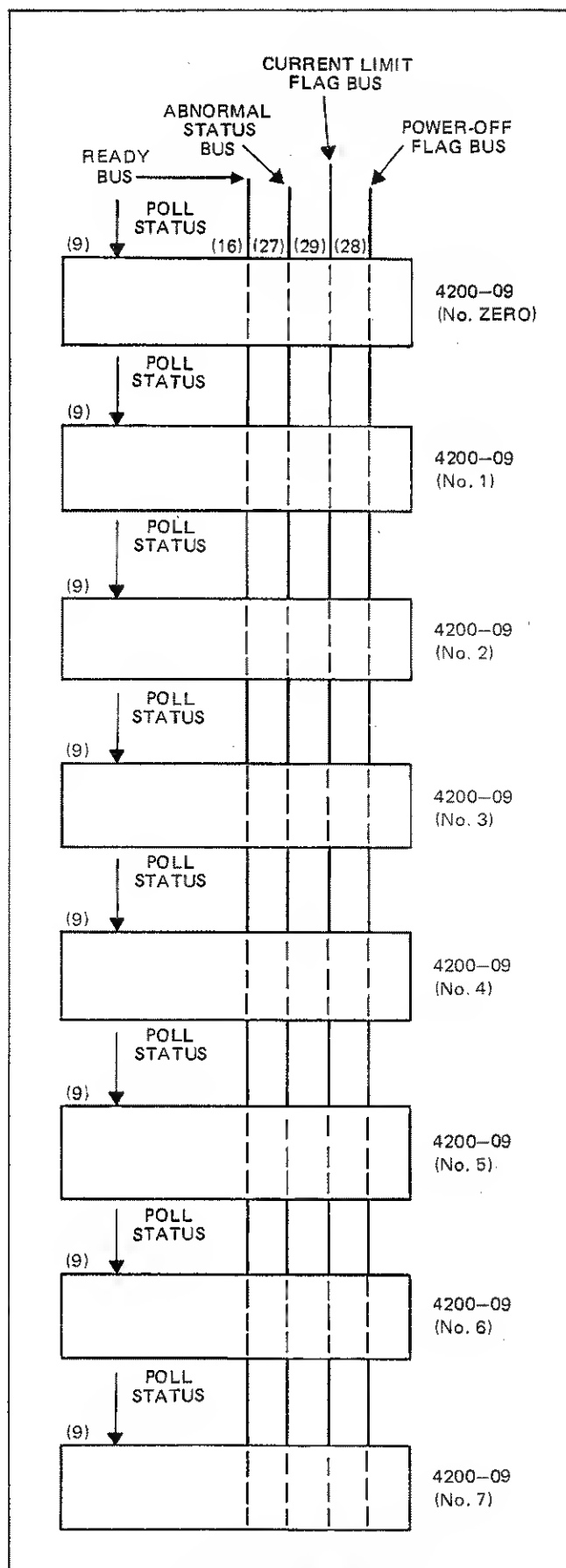
Figure 609-8. Status Busses

609-63. THEORY OF OPERATION

609-64. Overall Functional Description

609-65. Many diverse programming methods are possible, with different jumpering configurations, for all 4200-09 voltage sources. Since all possible configurations cannot be described in detail, these theory discussions are somewhat generalized. In any configuration, the primary function of the 4200-09 is to receive output magnitude data and control data, in parallel form, from a program source, and transfer that data across the voltage source guard shield to the voltage source D/A converter. Figure 609-9 is a simplified block diagram of the 4200-09, showing how data and control words are applied to shift registers in parallel form, clocked out of the registers in serial form, coupled across the guard shield and reconverted to parallel form for input to the voltage source D/A converter.

609-66. Upon receipt of a data word strobe or control word strobe, the control logic generates a load command to one or both shift registers. The data word and control word supplied by the program source and present at the shift register inputs, is loaded into the shift registers. When the shift registers are loaded with the program data, the control logic issues a hold command to the voltage source, then after a short delay, starts a 10 MHz clock.

609-67. Clock output pulses are fed to the shift registers to move the program data out of the registers, bit-by-bit, to the coupling transformers at the guard shield. When the program source indicates that the data word is a negative Binary number, the data word is shifted out of its storage register via two's complementing logic. This action is necessary since 4200 Binary Voltage Sources require positive Binary numbers in conjunction with a positive or negative polarity indicator. The control word undergoes no complementing at any time.

609-68. While the clock pulses are shifting program data across the guard shield, clock pulses are also being fed across the guard shield, and the hold one-shot is triggered as a result of the hold command issued by the control logic. On the inside of the guard shield, clock pulses shift the serial program data into shift registers which provide the necessary serial-to-parallel conversion. (The 4200 Voltage Sources require parallel program data.) The hold one-shot output is present for the duration of the serial data transfer across the guard shield. It inhibits any change in voltage source output magnitude while the data word is being serially loaded into the shift register.
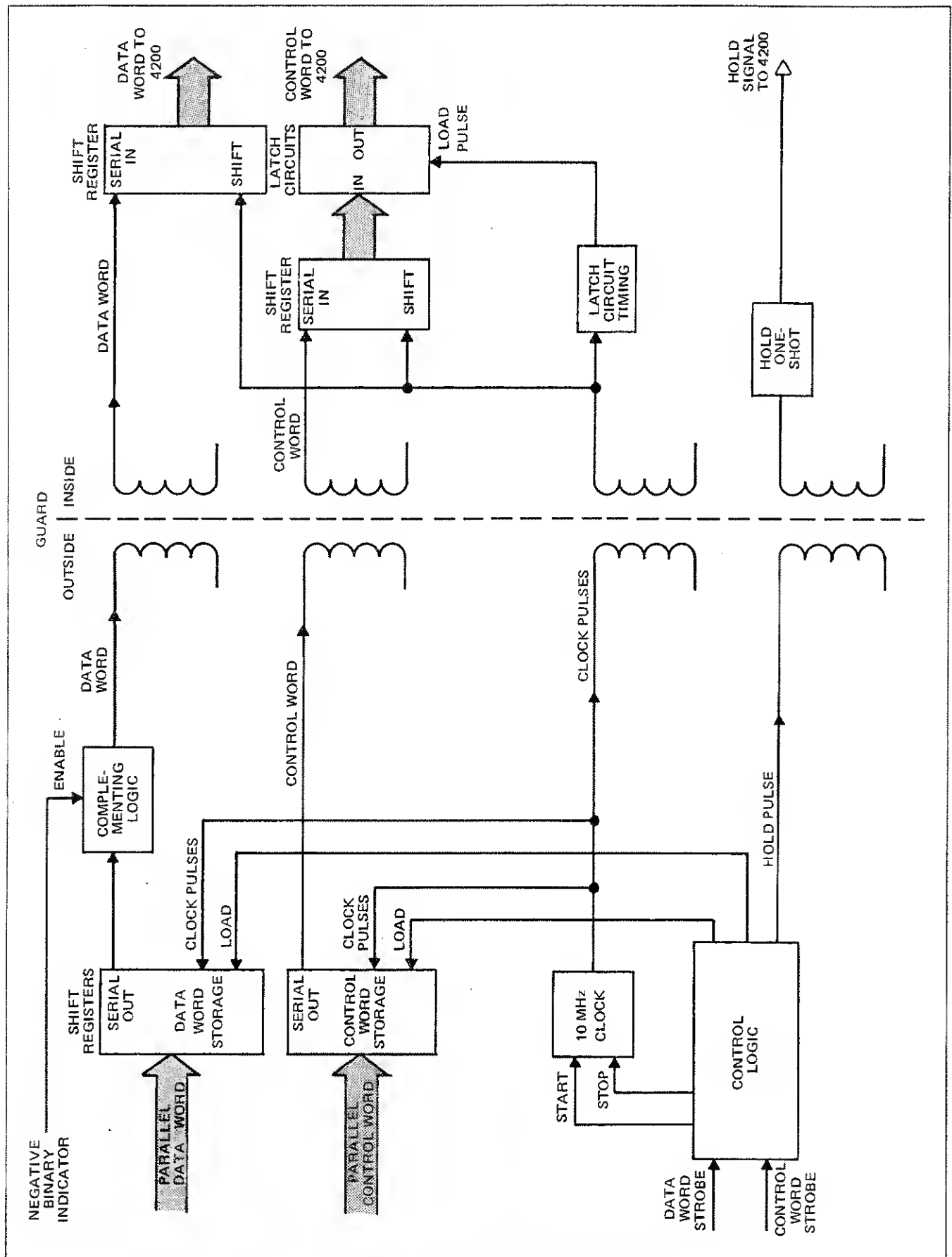
Figure 609-9. 4200-09 Simplified Block Diagram

609-69. The control word is also loaded into a shift register; it is double-buffered to prevent any change in voltage source output while loading is taking place. Double-buffering is provided by a series of latch circuits which receive a load pulse from a latch timing circuit. The latch timing circuit issues the load pulse to the latch circuits sometime after the last clock pulse when all data has been shifted into the registers. As the load pulse occurs, the latch circuits are loaded with the control word which they present in parallel form to the 4200 Voltage Source. (Double-buffering for the data word is not required since the hold signal "freezes" the voltage source output magnitude until the data word is completely loaded into the shift register.)

609-70. Clock pulses shift and load program data. Starting the clock pulses is a function of the control logic; stopping the clock pulses is also a function of the control logic, but after the generation of 16 pulses. When the clock is stopped, all shifting action ceases; and after the hold signal disappears and the load pulse to the latch occurs, all program data is presented to the digital-to-analog converter within the 4200 Voltage Source. At this time, the voltage source assumes its newly programmed output.

609-71. Block Diagram Analysis

609-72. INPUT SEQUENCE

609-73. Parallel program data, supplied by the program source, is applied to a pair of shift registers. (Refer to Figure 609-10.) Identical program data is supplied to all 4200-09 voltage sources in a multiple source system, but only those sources addressed by the program source will accept the data. Program data is loaded into the input registers only when an address signal and the appropriate strobe signal are present.

609-74. In a device configured for single-strobe operation, the control word strobe signal (in conjunction with the strobe control line) is used to load both the data word and control word into their respective registers. The strobe signal gating accepts the control word strobe from the program source, and depending upon the state ($+5$ volts or ground) of the strobe control line, directs the strobe signal to either the control word one-shot, or the data word one-shot. If the strobe control line directs the control strobe pulse to the control word one-shot, a pulse is generated and fed to the parallel-load input of the control word shift register. The pulse causes the shift register to load the parallel control word supplied by the program source. If the strobe control line directs the control strobe pulse to the data word one-shot, a pulse is fed to the parallel-load input of the data word shift register.

609-75. In a device configured for dual-strobe operation, both the control word strobe and data word strobe signals are used to load the program data from the program source. In this configuration, the control word strobe triggers the control word one-shot to load the control word into its shift register, and the data word strobe triggers the data word one-shot to load the data word. (Refer also to Figure 609-11.)

NOTE

For single strobe, dual strobe and strobe polarity jumpering configurations, refer to Figure 609-4.

609-76. DATA TRANSFER

609-77. Whenever the control word one-shot or data word one-shot is triggered, the resulting output triggers a first hold one-shot. (Refer also to Figure 609-11.) One output of the hold one-shot produces a hold pulse which is fed across the guard shield (via T2) to trigger a second hold one-shot. The second hold one-shot generates a hold pulse required by the voltage source to hold the output magnitude at the current value while magnitude data is being reprogrammed.

NOTE

The duration of the hold pulse depends upon the particular voltage source being used.

609-78. The trailing edge of the first hold one-shot output (triggered by the strobe signal) sets a data transfer flip-flop. The Q output of the data transfer flip-flop starts a 10 MHz clock, if not already operating (refer to Standby Sequence), and gates the clock pulses to the serial shift inputs of the control word and data word shift registers. (The clock pulses are also gated to the input of the -16 counter and to the primary winding of T4.) As each clock pulse is received by the shift registers, the previously loaded program data is shifted, serial-by-bit, out of the shift registers to the coupling transformers (T3 and T5) at the guard shield. On the inside of the guard shield, the serial data and control words are loaded into a second set of shift registers which are clocked by the pulses at the secondary of T4.

609-79. Clock pulses gated by the data transfer flip-flop are also fed to a 4-bit Binary counter which produces a carry pulse at the time of the sixteenth clock pulse. The carry pulse resets the data transfer flip-flop to inhibit the gating of the clock pulses and stop the clock, if the standby mode is not present. (Refer to Standby Sequence.) After the generation and gating of 16 clock pulses, the data has shifted completely around the shift register and has been restored in the register exactly as it was prior to the data transfer. Data has also been transformer-coupled across the guard and into the second shift register for application to the 4200 Voltage Source.

The control word, since it contains eight bits or less, is actually shifted around the control word register, across the guard and into the second control word register two complete times during the 16 clock pulses.

609-80. The control word is double-buffered for application to the 4200 Voltage Source. This is necessary since the hold signal, provided during data transfer by the second hold one-shot, does not "freeze" the output range of the 4200 Voltage Source, just the output magnitude. To parallel shift the control word from the shift register to a set of latch circuits, the first of the 16 clock pulses triggers a latch timing one-shot which has a pulse width slightly greater than the serial data transfer time (16 clock pulses). The trailing edge of the latch timing one-shot output is fed to a pulse generator which provides a load pulse to the latch circuits. At the time of the load pulse, the latch circuits are parallel loaded with the control word for application to the 4200 Voltage Source.

609-81. COMPLEMENTING BINARY DATA

NOTE

Complementing magnitude data occurs only in Binary-type voltage sources.

609-82. Binary program sources usually supply two's complemented magnitude data, and a polarity bit for negative outputs. Binary type voltage sources require non-complemented Binary data and a polarity bit. Therefore, negative Binary magnitude data (complemented data) from the program source must be recomplemented to satisfy voltage source requirements.

609-83. The first bit of serial data is present at the shift register output before the $\div 16$ counter and complement flip-flop receive the first of 16 clock pulses. At that time, the $\div 16$ counter is in its zero state and the complement flip-flop is still reset, a result of the $\div 16$ counter carry pulse at the end of the previous data transfer. With the complement flip-flop in a reset state, the complement logic is disabled, and no inversion of serial data occurs. Data will be serially shifted until the first "1" data bit. With a "1" at the complement flip-flop, the trailing edge of the clock pulse sets the complement flip-flop. The first "1" bit is therefore tranferred non-inverted. All data bits after the first one are inverted, except the last bit which is the polarity bit. The carry output from the $\div 16$ counter is coincident with the last clock pulse, so the leading edge of the carry pulse resets the complement flip-flop. Since this takes place just prior to the last data bit, the last bit is tranferred non-inverted. If it is necessary to invert the last data bit, pad $\overline{A}$ may be jumpered to pad $\overline{C}$, placing U13 in the carry bit circuit to produce a delay. With the carry bit delayed, the last data bit will be complemented before the complement flip-flop is reset.

609-84. STANDBY OPERATION

609-85. Programming the 4200 Voltage Source to standby (zero output, but no change in programmed magnitude and range) may be performed in a synchronous or asynchronous manner, depending on jumper configuration. With synchronous standby operation, the standby bit supplied by the program source becomes part of the control word and is serially shifted across the guard for application to the standby input of the 4200 Voltage Source. This mode is referred to as synchronous standby because commanding the 4200 Voltage Source to standby or operate is always synchronous with a strobe signal from the program source.

609-86. With the 4200-09 jumper configured for asynchronous standby operation, the voltage source can be commanded to either the standby or operate mode independent of data transfer. The standby signal, a dc level, is gated to the 10 MHz clock to initiate clock pulse generation. If a data transfer sequence is not in progress, the data transfer flip-flop will be in its reset condition. Clock pulses and the data transfer flip-flop Q output (false) must be coincident for standby pulses to be gated across guard shield transformer T2. With the data transfer flip-flop in the reset state, the Q output prohibits clock pulses from reaching the $\div 16$ counter and the shift registers. Clock pulses, from the secondary winding of transformer T2, are input for a half-wave rectifier. The rectifier produces a dc output to the 4200 Voltage Source standby/operate input.

609-87. NOT READY SIGNAL

609-88. A Not Ready signal is initiated when a strobe signal initiates data transfer. Strobe signal gating circuitry triggers either the Control Word One-Shot or the Data Word One-Shot. They, in turn, trigger the First Hold One-Shot. The First Hold One-Shot triggers the Data Transfer Flip-Flop and the Not Ready One-Shot. The Not Ready One-Shot pulse is present through the data transfer time and lasts until the voltage source settles at its newly programmed output. Not Ready pulse duration is dependent on component selection.

609-89. Resistive and capacitive components in the Not Ready One-Shot circuit are selectable to establish different one-shot signal durations. A fixed time period is established by component selection with pad M jumpered directly to pad L. A variable time period is possible if a potentiometer is installed between pad M and pad L in place of the jumper. (Refer to Figure 609-4.)

Figure 609-10. 4200-09 Functional Block Diagram

SIGN BIT INDICATING
POS. BINARY OR ANY
BCD DATA

U14

A

B

U14

SIGN BIT
INDICATING
NEG. BINARY DATA

U13

T5

SERIAL DATA WORD

DATA WORD
SHIFT
REGISTER

U24,U25

DATA
WORD
TO 4200

14 BITS
OR
16 BITS

C   CLOCK PULSES

T4

CLOCK IN

D

U13

T3

SERIAL
WORD

CLOCK
IN

CONTROL

CONTROL
WORD SHIFT
REGISTER

U26

CONTROL
WORD

LATCH
CIRCUITS

U27

CONTROL
WORD
TO 4200

UP TO
8 BITS

E   CLOCK PULSES

10MHz
CLOCK

Q1,Q2

F   START
STOP

U11

G   OATA TRANSFER

T2

STANDBY
PULSES

CLOCK
PULSES

LATCH
TIMING
ONE-SHOT

U30

TIMING
PULSE

PULSE
GENERATOR

U29

LOAD
PULSE

GATED CLOCK
PULSES

HALF-WAVE
RECTIFIER

CR16

DC OUTPUT   STANDBY

H   HOLD PULSES

T6

SECOND
HOLD
ONE-SHOT

U23

HOLD SIGNAL

J   HALF-WAVE
RECTIFIER

CR3

OSCILLATOR SIGNAL

T1

CURRENT
LIMIT
OSCILLATOR

O12,O23
O25

ENABLE

CURRENT
LIMIT FLAG

Figure 609-10. 4200-09 Functional Block Diagram (cont)

Figure 609-11. Input Sequence - Timing Diagram

609-90. STATUS LOGIC

609-91. Voltage sources, through the 4200-09, can provide two status indications: current limit and power failure. Either status indication is accompanied by an Abnormal Status flag, usually used as a program source interrupt to initiate a status poll sequence. The voltage source supplies a current limit indication when an overload condition exists and the current limit function is in use. The Power Fail flag is generated within the 4200-09 Multi-Strobe Isolated Logic.

609-92. A Current Limit flag occurs when the voltage source generates a current limit signal. The current limit signal is passed to the 4200-09 Option, where it enables a current limit oscillator circuit. Oscillator output, coupled across T1, is half-wave rectified, then AND gated with the program source Status Enable signal to produce a Current Limit flag output. The current limit signal from the rectifier, through OR gating, also initiates an Abnormal Status flag.

609-93. A Power Fail flag occurs when the voltage to the 4200-09 logic fails. Power Fail flag circuitry requires a positive 5V input to supply Vcc to the power fail logic when power does fail. Under normal operating conditions, Vcc maintains a high logic state at one input of an AND circuit. The poll status signal at the other

input is ground level so no output is produced. If Vcc should fail, then low logic levels will be present at both inputs and the Power Fail flag will respond with a low logic output. The Abnormal Status line will also respond with low logic out.

609-94. MAINTENANCE

WARNING

THESE SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID ELECTRIC SHOCK, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN THE OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.

609-95. Performance Test

609-96. Proper 4200-09 operation is best verified in a normal operating environment. With the 4200-09 installed in a voltage source and connected to a program source, diagnostic routines may be used or manually-entered statements from an operator interface may be employed to test performance. The specific procedure will necessarily vary with each system.

NOTE

A manual test fixture, Fluke part number A4209, may be used in conjunction with an A4200 manual control unit for test purposes. It is available from the Parts Department, John Fluke Mfg. Co. Inc., P.O. Box 43210, Mountlake Terrace, WA 98043; telephone (206) 774-2211. Send all orders or inquiries to the attention of the Parts Department Manager.

609-97. The 4200-09 requires no adjustment, either periodically or after repair.

609-98. Troubleshooting Procedures

609-99. Troubleshooting information is presented in six separate tables. The first table, Table 609-5, is an overall Malfunction Isolation Procedure; each of the remaining five tables provides troubleshooting procedures dependent on the malfunction symptom. The preceding theory of operation should be read and understood prior to troubleshooting.

NOTE

Place 4200-09 pcb assembly on an extender card (Fluke part number 292263) for access during troubleshooting.

Table 609-5. Troubleshooting Chart, Inactive Module

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
1	Does Control or Data Word One-Shot fire when strobed?	5	2
2	Is the strobe pulse $\geqslant 1\ \mu s$?	4	3
3	Check strobe pulse source.		
4	Check logic elements preceding one-shot.		
5	Does First Hold One-Shot fire?	7	6
6	Repair First Hold One-Shot circuit.		
7	Does Data Transfer Flip-Flop, pin 6, go to Logic 0 (1.6 μs)?	9	8
8	Check logic elements between First Hold One-Shot and Data Transfer Flip-Flop.		
9	Is clock generating 10 MHz?	11	10
10	Check and repair clock circuit.		
11	Are clock pulses present at pin 8 of the shift register inside the guard?	13	12
12	Check all elements between clock circuit and shift registers.		
13	Is serial data present at guard transformers?	15	14
14	Check input shift registers and logic elements.		
15	Is serial data present at shift registers inside the guard?	17	16
16	Check transistors and amplifiers between guard transformers and shift registers inside guard.		
17	Does parallel data appear at outputs of shift registers inside the guard?	19	18
18	Check shift registers inside the guard.		
19	Perform the Voltage Source troubleshooting procedure in the applicable Voltage Source Instruction Manual.		

Table 609-6. Troubleshooting Chart, Data Errors at Parallel Outputs

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
1	Is program data correct at parallel input shift registers?	3	2
2	Check the program data source.		
3	Is serial data correct at output of the shift registers?	7	4
4	Is program data shifted on position to the left or right?	6	5
5	Check appropriate input shift register.		
6	Check the divide by 16 counter.		
7	Check the serial inputs and parallel outputs of the shift registers inside the guard.		

Table 609-7. Troubleshooting Chart, No Binary Data Complementing

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
1	Does polarity storage flip-flop output change states between positive and negative data?	7	2
2	Do polarity storage flip-flop inputs change states between positive and negative data?	4	3
3	Check the polarity input line and inverters.		
4	Does the polarity storage flip-flop receive a clock pulse?	6	5
5	Check all strobe input logic elements.		
6	Replace the polarity storage flip-flop.		
7	Does the complement flip-flop change states after the first true data bit?	9	8
8	Replace the complement flip-flop.		
9	Check all gates of the inverting and complemented data gating chip.		

Table 609-8. Troubleshooting Chart, No Asynchronous Standby

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
1	Are clock pulses present at pin 13 of U11 when standby selected?	5	2
2	Is pin 11 of U12 at Logic 0?	4	3
3	Check Standby/Operate input line.		
4	Check 10 MHz clock.		
5	Is pin 12 of U11 at Logic 0?	7	6
6	Check data transfer flip-flop and divide by 16 counter carry output.		
7	Is U21 input (pin 13) at +2V or higher?	9	8
8	Check elements in primary and secondary circuits of T2.		
9	Check for excessive ripple at input (pin 13) of U21.		

NOTE:
Logic 1 = zero to 0.4V
Logic 0 = +2V to +5V

Table 609-9. Troubleshooting Chart, No Current Limit Flag

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
1	Is poll status line at zero volts?	3	2
2	Place zero volts on poll status line.		
3	Is the output of the half wave rectifier circuit zero volts?	7	4
4	Is junction of CR3 and C15 greater than +2V?	8	5
5	Is AC signal present at collector of Q12?	9	6
6	Troubleshoot current limit oscillator and/or power source flag input.		
7	Check current limit flag status gate logic.		
8	Replace amplifier U7 and check for excessive ripple of CR3.		
9	Check T1 and associated circuitry.		

Table 609-10. Troubleshooting Chart, No Power Fail and/or Abnormal Status Flag

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
1	Are both Abnormal Staus and Power Fail flags malfunctioning?	2	3
2	Check Vcc (+5V) supply from Program Source.		
3	Has the Abnormal Status flag failed?	5	4
4	Check Polled Power Fail flag status gate logic.		
5	Does Current Limit flag operate normally?	6	7
6	Check Abnormal Status flag status gate circuitry.		
7	Troubleshoot Current Limit flag circuitry.		

609-100. ILLUSTRATED PARTS LIST

609-101. Components in the illustrated parts breakdown are listed alphanumerically by assembly. See Table 609-11. Electrical and mechanical components are listed by reference designation. Each listed part is shown in an accompanying illustration. For parts ordering information, refer to Section 5.

NOTE

The following parts list includes timing components necessary to use the 4200-09 Option in a 4210A or 4216A Voltage Source. See Addendum 609-11A, for component values and Fluke part numbers used in 4200-09 Option units installed in 4250A, 4265A, 4270A and 4275A Voltage Sources.

Table 609-11. Multi-Strobe Isolated Logic PCB Assembly

REF OES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE COE
	MULTI-STROBE ISOLATED LOGIC PCB ASSY. FIGURE 6-12	345660	89536	345660			
C1	CAP, MICA, 12 PF +/-5%, 500V	175224	72136	DM15E120J	2		
C2	CAP, MICA, 12 PF +/-5%, 500V	175224	72136	DM15E120J	REF		
C3	CAP, MICA, 750 PF +/-5%, 500V	208983	72136	DM19F751J	1		
C4	CAP, TA, 10 UF +/-20%, 15V	193623	.56289	196D106X0015	1		
C5	CAP, MICA 220 PF +/-5%, 500V	170423	72136	DM15F221J	2		
C6	CAP, MICA, 470 PF +/-5%, 500V	148429	72136	DM19F471J	1		
C7	CAP, MICA, 1000 PF +/-5%, 500V	148387	72136	DM19F102J	1		
C8	CAP, MICA, 70 PF +/-5%, 500V	148494	72136	DM15F700J	3		
C9	CAP, MICA, 70 PF +/-5%, 500V	148494	72136	DM15F700J	REF		
C10	CAP, MICA, 270 PF +/-5%, 500V	148452	72136	DM15F271J	1		
C11	CAP, FILM, 0.0033 PF +/-2%, 150V	168344	84171	PE332G	1		▷
C15	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103	2		▷
C20	CAP, MICA, 330 PF +/-1%, 500V	226142	72136	DM15E331F	1		▷
C21	CAP, MICA, 70 PF +/-5%, 500V	148494	72136	DM15F700J	REF		
C22	CAP, MYLAR, 0.1 UF +/-10%, 50V	271866	06001	75F2R5A104	1		
C34	CAP, CER, 0.025 UF +/-20%, 100V	168435	56289	C023B101H253	19		
C35	CAP, CER, 0.025 UF +/-20%, 100V	168435	56289	C023B101H253	REF		
C36	CAP, CER, 0.025 UF +/-20%, 100V	168435	56289	C023B101H253	REF		
C37	CAP, CER, 0.025 UF +/-20%, 100V	168435	56289	C023B101H253	REF		
C38	CAP, CER, 0.025 UF +/-20%, 100V	168435	56289	C023B101H253	REF		
C39	CAP, CER, 0.025 UF +/-20%, 100V	168435	56289	C023B101H253	REF		
C40	CAP, CER, 0.025 UF +/-20%, 100V	168435	56289	C023B101H253	REF		
C41	CAP, CER, 0.025 UF +/-20%, 100V	168435	56289	C023B101H253	REF		
C42	CAP, ELECT, 200 UF +/-50%, 10V	236935	73445	ET221X010A5	2		
C43	CAP, ELECT, 200 UF +/-50%, 10V	236935	73445	ET221X010A5	REF		
C44	CAP, MICA, 56 PF +/-5%, 500V	148528	72136	DM15F560J	5		
C45	CAP, MICA, 56 PF +/-5%, 500V	148528	72136	DM15F560J	REF		
C46	CAP, MICA, 56 PF +/-5%, 500V	148528	72136	DM15F560J	REF		
C47	CAP, MICA, 56 PF +/-5%, 500V	148528	72136	DM15F560J	REF		
C48	CAP, MICA 220 PF +/-5%, 500V	170423	72136	DM15F221J	REF		
C49	CAP, MICA, 56 PF +/-5%, 500V	148528	72136	DM15F560J	REF		
C53	CAP, CER, 0.01 UF +,-20%, 100V	149153	56289	C023B101F103	REF		
C55	CAP, CER, .0027 PF +/-GMV, 600V	106211	72982	851.000Z5U0-272P	1		
C56	CAP, CER, 0.025 UF +/-20%, 100V	168435	56289	C023B101H253	REF		
C57	CAP, CER, .0033 UF +/-GMV, 600V	106674	56289	C023B102F332M	1		
C58	CAP, CER, 0.025 UF +/-20%, 100V	168435	56289	C023B101H253	REF		
C59	CAP, CER, 0.025 UF +/-20%, 100V	168435	56289	C023B101H253	REF		
C60	CAP, CER, 0.025 UF +/-20%, 100V	168435	56289	C023B101H253	REF		
C61	CAP, CER, 0.025 UF +/-20%, 100V	168435	56289	C023B101H253	REF		
C62	CAP, CER, 0.025 UF +/-20%, 100V	168435	56289	C023B101H253	REF		
C63	CAP, CER, 0.025 UF +/-20%, 100V	168435	56289	C023B101H253	REF		
C64	CAP, CER, 0.025 UF +/-20%, 100V	168435	56289	C023B101H253	REF		
C65	CAP, CER, 0.025 UF +/-20%, 100V	168435	56289	C023B101H253	REF		
C66	CAP, CER, 0.025 UF +/-20%, 100V	168435	56289	C023B101H253	REF		
C67	CAP, CER, 0.025 UF +/-20%, 100V	168435	56289	C023B101H253	REF		
C68	CAP, MICA, 430 PF +/-5%, 500V	177980	72136	DM15F431J	3		
C69	CAP, MICA, 430 PF +/-5%, 500V	177980	72136	DM15F431J	REF		
C70	CAP, MICA, 430 PF +/-5%, 500V	177980	72136	DM15F431J	REF		

Table 609-11. Multi-Strobe Isolated Logic PCB Assembly (cont)

REF OES	OESCRIPTION	FLUKE STOCK NO.	MFG SPLY COOE	MFG PART NO. OR TYPE	TOT OTY	REC OTY	USE COE
CR1	DIODE, SI, 150 MA	203323	04713	1N4448	7		
CR2	DIODE, HOT CARRIER	313247	28480	2811	7	2	
CR3	DIODE, HOT CARRIER	313247	28480	2811	REF		
CR4	DIODE, HOT CARRIER	313247	28480	2811	REF		
CR5	DIODE, HOT CARRIER	313247	28480	2811	REF		
CR6	DIODE, HOT CARRIER	313247	28480	2811	REF		
CR7	DIODE, SI, 150 MA	203323	04713	1N4448	REF		
CR8	DIODE, SI, 150 MA	203323	04713	1N4448	REF		
CR9	DIODE, SI, 150 MA	203323	04713	1N4448	REF		
CR10	DIODE, SI, 150 MA	203323	04713	1N4448	REF		
CR11	DIODE, HOT CARRIER	313247	28480	2811	REF		
CR12	DIODE, HOT CARRIER	313247	28480	2811	REF		
CR15	DIODE, SI, 150 MA	203323	04713	1N4448	REF		
CR16	DIODE, SI, 150 MA	203323	04713	1N4448	REF		
Q1	XSTR, SI, NPN	159855	07910	CS23030	17	6	
Q2	XSTR, SI, NPN	159855	07910	CS23030	REF		
Q3	XSTR, SI, NPN	159855	07910	CS23030	REF		
Q6	XSTR, SI, NPN	159855	07910	CS23030	REF		
Q7	XSTR, SI, NPN	159855	07910	CS23030	REF		
Q8	XSTR, SI, NPN	159855	07910	CS23030	REF		
Q10	XSTR, SI, NPN	159855	07910	CS23030	REF		
Q11	XSTR, SI, NPN	159855	07910	CS23030	REF		
Q12	XSTR, SI, NPN	159855	07910	CS23030	REF		
Q13	XSTR, SI, UNIJUNCTION	268110	03508	2N6027	1	1	
Q14	XSTR, SI, NPN	159855	07910	CS23030	REF		
Q16	XSTR, SI, NPN	159855	07910	CS23030	REF		
Q17	XSTR, SI, NPN	159855	07910	CS23030	REF		
Q18	XSTR, SI, NPN	159855	07910	CS23030	REF		
Q19	XSTR, SI, NPN	159855	07910	CS23030	REF		
Q20	XSTR, SI, NPN	159855	07910	CS23030	REF		
Q23	XSTR, SI, NPN	168716	12040	SM07154	1		
Q25	XSTR, SI, PNP	195974	04713	2N3906	1	1	
Q26	XSTR, SI, NPN	159855	07910	CS23030	REF		
Q27	XSTR, SI, NPN	159855	07910	CS23030	REF		
R1	RES, COMP, 1K+/-5%, 1/4W	148023	01121	CB1025	12		
R2	RES, COMP, 10K+/-5%, 1/4W	148106	01121	CB1035	2		
R3	RES, COMP, 510+/-5%, 1/4W	218032	01121	CB5115	8		
R4	RES, COMP, 10K+/-5%, 1/4W	148106	01121	CB1035	REF		
R5	RES, COMP, 470+/-5%, 1/4W	234252	01121	CB1325	1		
R6	RES, COMP, 1.3K+/-5%, 1/4W	234252	01121	CB1325	1		
R7	RES, COMP, 390+/-5%, 1/4W	147975	01121	CB3915	5		
R8	RES, COMP, 390+/-5%, 1/4W	147975	01121	CB3915	REF		
R9	RES, COMP, 510+/-5%, 1/4W	218032	01121	CB5115	REF		
R10	RES, COMP, 510+/-5%, 1/4W	218032	01121	CB5115	REF		
R11	RES, MTL FLM, 6.98K+/-1%, 1/8W	261685	91637	MFF1-86981F	2		
R13	RES, COMP, 510+/-5%, 1/4W	218032	01121	CB5115	REF		
R14	RES, COMP, 390+/-5%, 1/4W	147975	01121	CB3915	REF		
R15	RES, MTL FLM, 4.99K+/-1%, 1/8W	168252	91637	MFF1-84991F	2		
R16	RES, COMP, 11+/-5%, 1/4W	221861	01121	CB1105	2		
R17	RES, MTL FLM, 4.99K+/-1%, 1/8W	168252	91637	MFF1-84991F	REF		

Table 609-11. Multi-Strobe Isolated Logic PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R18	RES, COMP, 51+/-5%, 1/4W	221879	01121	CB5105	6		
R19	RES, MTL FLM, 29.4K+/-1%, 1/8W	235135	91637	MFF1-82942F	1		▷1
R20	RES, COMP, 2.7K +/-5%, 1/4W	170720	01121	CB2725	1		
R21	RES, COMP, 510+/-5%, 1/4W	218032	01121	CB5115	REF		
R22	RES, COMP, 1K+/-5%, 1/4W	148023	01121	CB1025	REF		
R23	RES, COMP, 510+/-5%, 1/4W	218032	01121	CB5115	REF		
R24	RES, COMP, 1K+/-5%, 1/4W	148023	01121	CB1025	REF		
R26	RES, COMP, 51+/-5%, 1/4W	221879	01121	CB5105	REF		
R28	RES, COMP, 1K+/-5%, 1/4W	148023	01121	CB1025	REF		
R30	RES, COMP, 430+/-5%, 1/4W	203869	01121	CB4315	1		
R32	RES, COMP, 200+/-5%, 1/4W	193482	01121	CB2015	4		
R35	RES, COMP, 3.3K+/-5%, 1/4W	148056	01121	CB3325	6		
R36	RES, COMP, 1K+/-5%, 1/4W	148023	01121	CB1025	REF		
R37	RES, COMP, 200+/-5%, 1/4W	193482	01121	CB2015	REF		
R38	RES, COMP, 200+/-5%, 1/4W	193482	01121	CB2015	REF		
R39	RES, COMP, 3.3K+/-5%, 1/4W	148056	01121	CB3325	REF		
R40	RES, MTL FLM, 30.9K+/-1%, 1/8W	235275	91637	MFF1-83092F	1		▷1
R42	RES, COMP, 390+/-5%, 1/4W	147975	01121	CB3915	REF		
R43	RES, COMP, 11+/-5%, 1/4W	221861	01121	CB1105	REF		
R45	RES, COMP, 1K+/-5%, 1/4W	148023	01121	CB1025	REF		
R47	RES, COMP, 27K+/-5%, 1/4W	148148	01121	CB2735	1		
R48	RES, COMP, 3.3K+/-5%, 1/4W	148056	01121	CB3325	REF		
R49	RES, COMP, 39K+/-5%, 1/4W	188466	01121	CB3935	1		
R50	RES, COMP, 390+/-5%, 1/4W	147975	01121	CB3915	REF		
R51	RES, COMP, 100+/-5%, 1/4W	147926	01121	CB1015	1		
R54	RES, COMP, 3.3K+/-5%, 1/4W	148056	01121	CB3325	REF		
R59	RES, COMP, 1K+/-5%, 1/4W	148023	01121	CB1025	REF		
R60	RES, COMP, 1K+/-5%, 1/4W	148023	01121	CB1025	REF		
R61	RES, COMP, 1K+/-5%, 1/4W	148023	01121	CB1025	REF		
R62	RES, COMP, 680+/-5%, 1/4W	148007	01121	CB6815	3		
R63	RES, COMP, 51+/-5%, 1/4W	221879	01121	CB5105	REF		
R64	RES, COMP, 51+/-5%, 1/4W	221879	01121	CB5105	REF		
R65	RES, COMP, 51+/-5%, 1/4W	221879	01121	CB5105	REF		
R67	RES, COMP, 680+/-5%, 1/4W	148007	01121	CB6815	REF		
R68	RES, COMP, 680+/-5%, 1/4W	148007	01121	CB6815	REF		
R69	RES, COMP, 510+/-5%, 1/4W	218032	01121	CB5115	REF		
R70	RES, COMP, 1K+/-5%, 1/4W	148023	01121	CB1025	REF		
R71	RES, MTL FLM, 10K+/-1%, 1/8W	168260	91637	MFF1-81002F	1		
R72	RES, COMP, 510+/-5%, 1/4W	218032	01121	CB5115	REF		
R73	RES, COMP, 1K+/-5%, 1/4W	148023	01121	CB1025	REF		
R75	RES, COMP, 1K+/-5%, 1/4W	148023	01121	CB1025	REF		
R81	RES, COMP, 3.3K+/-5%, 1/4W	148056	01121	CB3325	REF		
R86	RES, COMP, 1.6K+/-5%, 1/4W	266197	01121	CB1625	1		
R87	RES, COMP, 2K+/-5%, 1/4W	202879	01121	CB2025	1		
R88	RES, COMP, 200+/-5%, 1/4W	193482	01121	CB2015	REF		
R89	RES, COMP, 3.3K+/-5%, 1/4W	148056	01121	CB3325	REF		
R91	RES, COMP, 51+/-5%, 1/4W	221879	01121	CB5105	REF		
T1	TRANSFORMER	299594	89536	299594	6		
T2	TRANSFORMER	299594	89536	299594	REF		

Table 609-11. Multi-Strobe Isolated Logic PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE COE
T3	TRANSFORMER	299594	89536	299594	REF		
T4	TRANSFORMER	299594	89536	299594	REF		
T5	TRANSFORMER	299594	89536	299594	REF		
T6	TRANSFORMER	299594	89536	299594	REF		
U1	IC, TTL, HEX INVERTER	292979	01295	SN7404N	3	1	
U2	IC, TTL, 4 BIT RIGHT/LEFT SHIFT REG.	342691	01295	SN7495AN	3	1	
U3	IC, TTL, 4 BIT RIGHT/LEFT SHIFT REG.	342691	01295	SN7495AN	REF		
U4	IC, TTL, 4 BIT RIGHT/LEFT SHIFT REG.	342691	01295	SN7495AN	REF		
U5	IC, TTL, MSI 8-BIT SHIFT REGISTER	293118	01295	SN74165N	2	1	
U6	IC, TTL, MSI, SYN 4-BIT UP/DWN CNTRS.	293183	01295	SN74193N	1	1	
U7	IC, TTL, HEX INVERTER	292979	01295	SN7404N	REF		
U8	IC, TTL, MSI 8-BIT SHIFT REGISTER	293118	01295	SN74165N	REF		
U9	IC, TTL, 3-IN POS NAND GATES	292995	01295	SN7410N	2	1	
U10	IC, TTL, MSI, RETRIG MONO MULTIVBRTR	293134	04713	MC8601P	2	1	
U11	IC, TTL, QUAD 2-IN NAND GATE	292953	01295	SN7400N	4	1	
U12	IC, TTL, QUAD 2-IN NAND GATE	292953	01295	SN7400N	REF		
U13	IC, TTL, QUAD 2-IN NAND GATE	292953	01295	SN7400N	REF		
U14	IC, TTL, DUAL HI/SPEED, AND/OR INVERT	293084	01295	SN74H51N	1	1	
U15	IC, TTL, J-K EDGE TRIG F/F	293092	01295	SN74H102N	1	1	
U16	IC, TTL, HEX INVERTER	292979	01295	SN7404N	REF		
U18	IC, TTL, MSI, RETRIG MONO MULTIVBRTR	293134	04713	MC8601P	REF		
U19	IC, TTL, DUAL RETRIG MONO MULTIVBRTR	310235	01295	SN74123N	1	1	
U20	IC, TTL, QUAD 2-IN NAND GATE	292953	01295	SN7400N	REF		
U21	IC, TTL, HEX INVERTER	293076	01295	SN74H04N	1	1	
U24	IC, TTL, 8-BIT SHIFT REGISTER	272138	12040	DM8570	3	1	
U25	IC, TTL, 8-BIT SHIFT REGISTER	272138	12040	DM8570	REF		
U26	IC, TTL, 8-BIT SHIFT REGISTER	272138	12040	DM8570	REF		
U27	IC, TTL, DUAL FOUR-BIT LATCH	293191	04713	MC8303P	1	1	
U28	IC, TTL, MONO MULTIVIBRATOR	293050	01295	SN74121N	2	1	
U29	IC, TTL, J-K MSTR SLAVE F/F	296491	01295	SN7472N	1	1	
U30	IC, TTL, MONO MULTIVIBRATOR	293050	01295	SN74121N	REF		

▷1 For usage on Models 4210 and 4216 only. See Table 609-11A for timing components used on the Models: 4250, 4265, 4270 and 4275 for R19, R40, C11 and C20 Ref. Des.
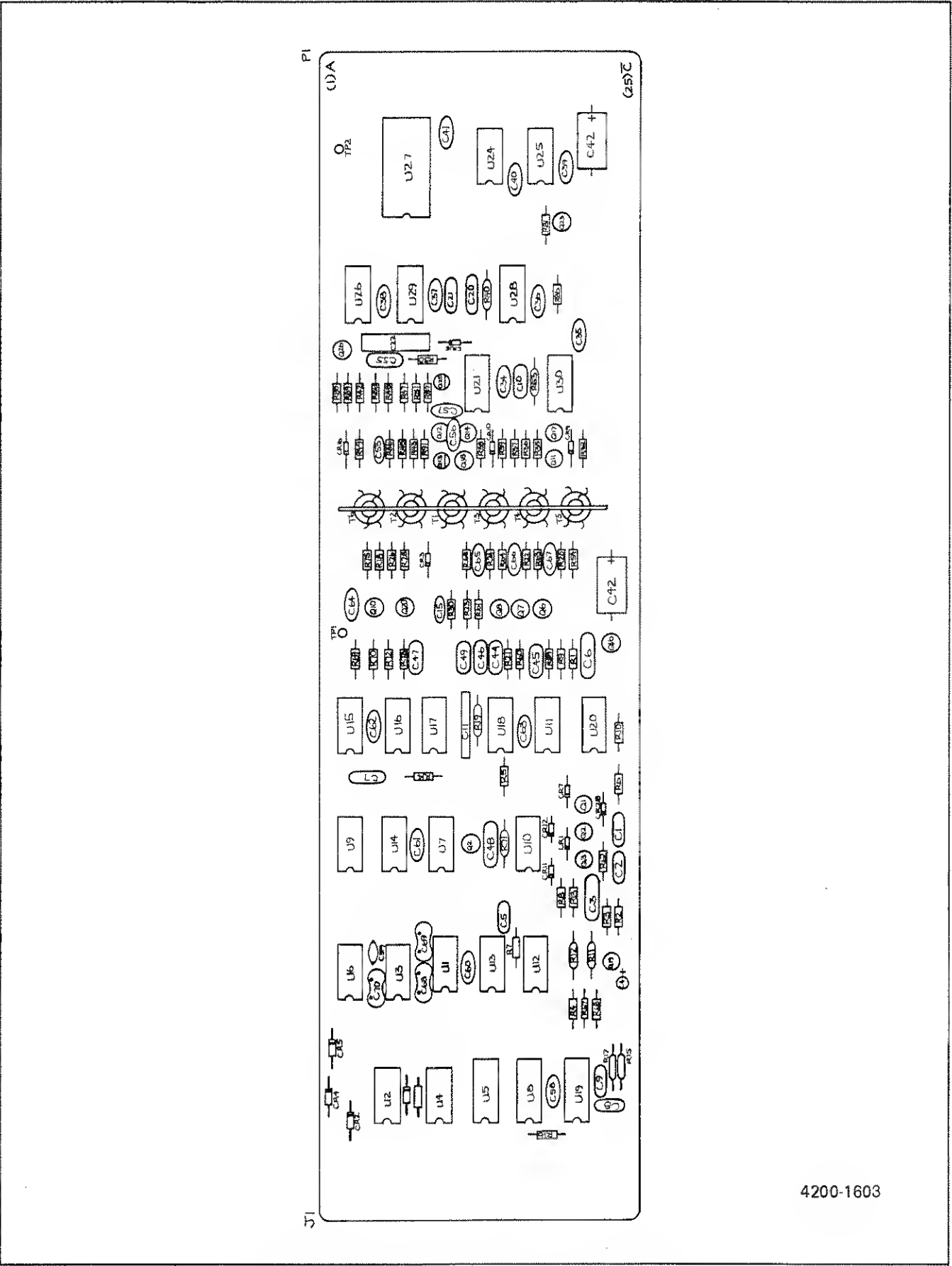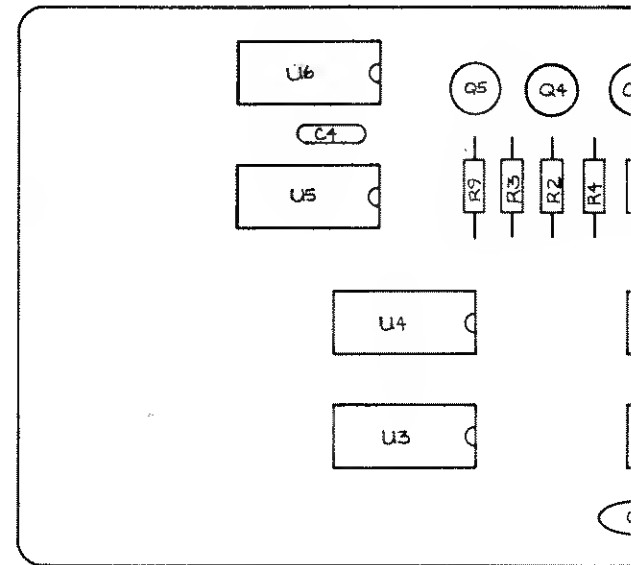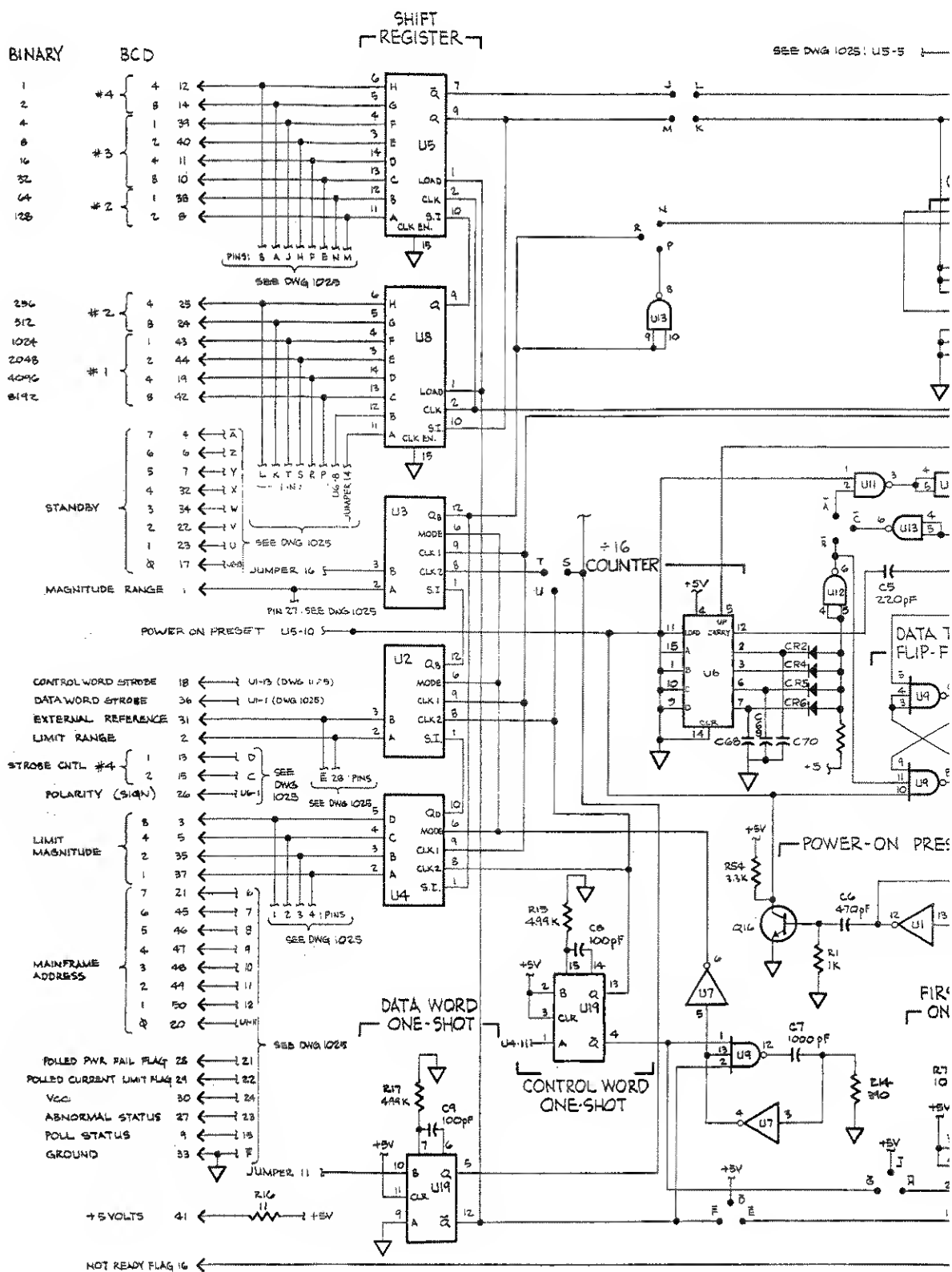
Figure 609-12. Multi-Strobe Isolated Logic PCB Assembly

4200-1603

Table 609-11A. Timing Components: 4250A, 4265A, 4270A, 4275A

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE COE
C11	CAP, POLY STYRN, 0.01 UF +/-2%, 150V	168385	02799	PE103G	1		
C20	CAP, MICA, 680 PF +/-1%, 500V	226159	72136	DM19F681F	1		
R19	RES, MTL. FILM, 32.4K +/-1%, 1/8W	182956	91637	CMF553242F	1		
R40	RES, MTL. FILM, 31.6K +/-1%, 1/8W	261610	91637	CMF553162F	1		

Table 609-12. 4200-09 Isolated Logic Piggyback PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE COE
	ISOLATED LOGIC PIGGY BACK PCB ASSY. FIGURE 6-13	341222	89536	341222			
C1	CAP, MICA, 330PF +/-5%, 500V	148445	72136	DM15F331J	2		
C2	CAP, CER, 0.22PF +/-5%, 50V	309849	32897	8131-05D-651-224M	2		
C3	CAP, MICA, 330PF+/-5%, 500V	148445	72136	DM15F331J	REF		
C4	CAP, CER, 0.22PF+/-5%, 50V	309849	32897	8131-05D-651-224M	REF		
CR1	DIODE, SI, 15D MA	203323	04713	1N4448	3	1	
CR2	DIODE, SI, 150 MA	203323	04713	1N4448	REF		
CR3	DIODE, SI, 15D MA	203323	04713	1N4448	REF		
Q1	XSTR, NPN, SI	159835	07910	CS23030	5	1	
Q2	XSTR, NPN, SI	159835	07910	CS2303D	REF		
Q3	XSTR, NPN, SI	159835	07910	CS23D30	REF		
Q4	XSTR, NPN, SI	159835	07910	CS23030	REF		
Q5	XSTR, NPN, SI	159835	07910	CS23030	REF		
R1	RES, COMP, 470+/-5%, 1/4W	147983	01121	CB4715	2		
R2	RES, COMP, 2K+/-5%, 1/4W	202879	01121	CB2025	1		
R3	RES, COMP 10K+/-5%, 1/4W	148106	01121	CB1035	4		
R4	RES, COMP 10K+/-5%, 1/4W	148106	01121	CB1035	REF		
R5	RES, COMP 10K+/-5%, 1/4W	148106	01121	CB1035	REF		
R6	RES, COMP 1DK+/-5%, 1/4W	148106	01121	CB1035	REF		
R7	RES, COMP, 470+/-5%, 1/4W	147983	01121	CB4715	REF		
R8	RES, COMP, 20K+/-5%, 1/4W	221614	01121	CB2035	1		
R9	RES, COMP, 4.7K+/-5%, 1/4W	148072	01121	CB4725	1		
U1	IC, DTL, HEX INVERTER	268367	01295	SN15836N	1	1	
U2	IC, TTL, HEX INVERTER	292979	01295	SN7404N	2	1	
U3	IC, TTL, QUAD 2-IN NOR GATE	288845	01295	SN74D2N	1	1	
U4	IC, TTL, QUAD 2-IN NAND GATE	292953	01295	SN7400N	1	1	
U5	IC, TTL, DUAL J-K F/F	293043	01295	SN741D7N	1	1	
U6	IC, TTL, HEX INVERTER	292979	01295	SN7404N	REF		

U6

C4

U5

Q5 Q4

R9 R5 R2 R4

U4

U3

BINARY   BCD

SHIFT REGISTER

SEE DWG 1025; U5-5

STANDBY

MAGNITUDE RANGE

POWER ON PRESET   U5-10

CONTROL WORD STROBE   18
DATA WORD STROBE   36
EXTERNAL REFERENCE   31
LIMIT RANGE   2
STROBE CNTL #4   1
POLARITY (SIGN)   26

LIMIT MAGNITUDE

MAINFRAME ADDRESS

POLLED PWR FAIL FLAG   28
POLLED CURRENT LIMIT FLAG   29
Vcc   30
ABNORMAL STATUS   27
POLL STATUS   9
GROUND   33

+5 VOLTS   41

NOT READY FLAG   16

÷16 COUNTER

DATA WORD ONE-SHOT

CONTROL WORD ONE-SHOT

POWER-ON PRESET

Model A4200

6-1. INTRODUCTION

6-2.   The Model A4200 Manual Control Unit (MCU) with attaching interface cable and connectors is a manually operated program source for the 4200A series power sources. Figure 6-1 shows the MCU connected to a typical FLUKE power source. The purpose of the MCU is to per-

mit an operator to fully exercise the programmable functions of any 4200A series power source, primarily for manual programming, calibration and adjustment, or for trouble-shooting. Secondly, a synchronized oscilloscope display of a 4200A series power source output may be established and controlled with an MCU.
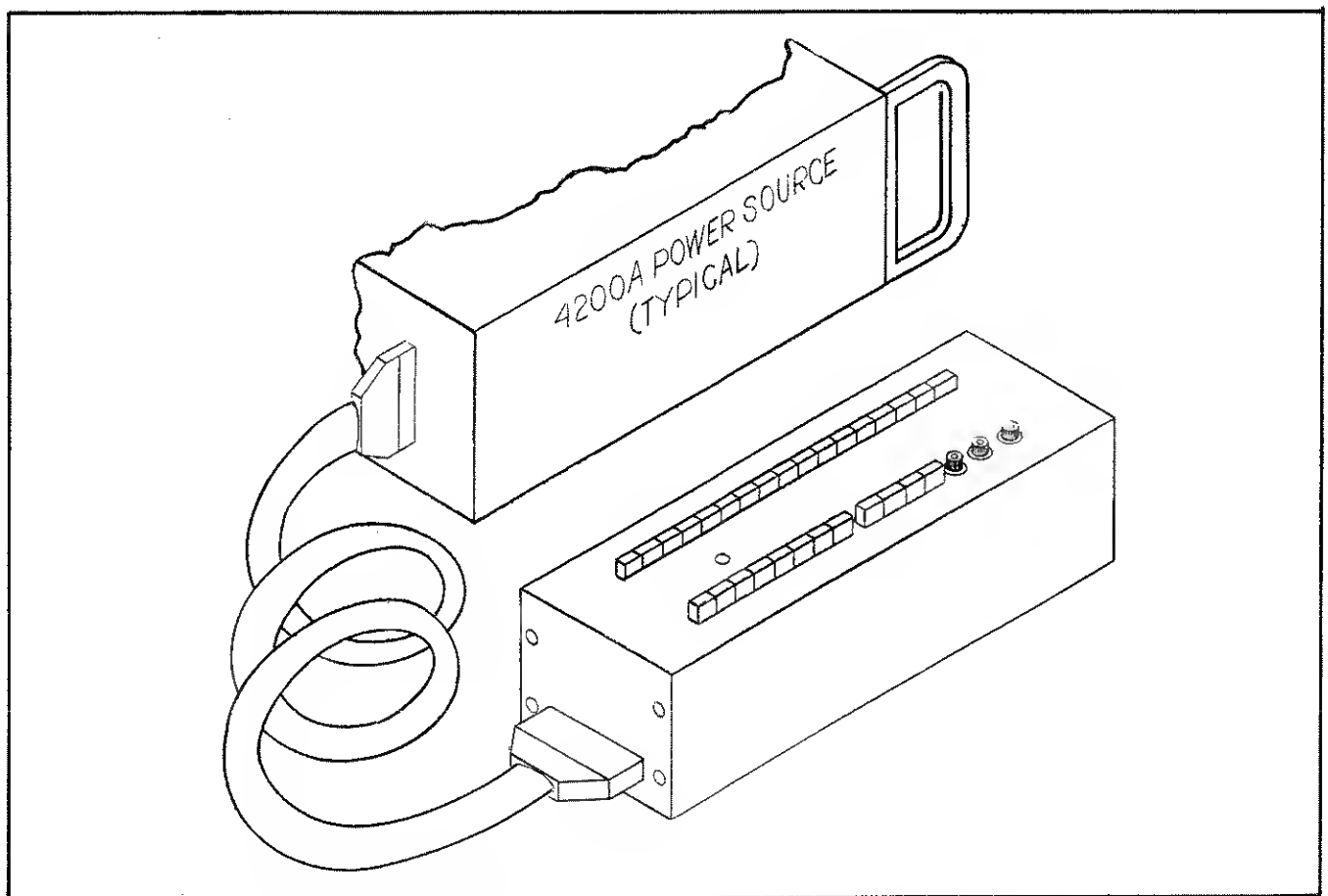

Figure 6-1. MODEL A4200 MANUAL CONTROL UNIT CONNECTED TO TYPICAL POWER SOURCE.

6-3. SPECIFICATIONS

6-4. There are no specifications for the Model A4200 MCU.

6-5. INSTALLATION

6-6. The MCU is supplied with an interface cable and connectors designed to fit any of the 4200A series power sources. The operating voltages for the MCU are supplied from the associated power source through the interface cable. The interface cable also supplies the power source with all programming inputs initiated by the MCU. Connection of the MCU to the power source via the interface cable is done as follows:

CAUTION!

The Model A4200 MCU is NOT compatible with the —09 option.

a.   Turn off the power source and disconnect the programming connector from the rear panel of the power source.

b.   Connect the interface cable connectors to both the programming connector on the power source and on the MCU.

c.   Select the desired operating configuration on the top panel of the MCU and then turn on the power source. The power source is now ready for operation with the MCU.

6-7. OPERATING INSTRUCTIONS

6-8. The location and function of the MCU controls, indicators and connectors are described in Figure 6-2. The active or high level logic state of the pushbutton switches on the MCU is the depressed or *in* state. However, in the event the associated power source is equipped with the inverted logic option (08 Option), the logic level states of all pushbuttons defined below is high when the pushbuttons are extended or *out*. When depressed or *in*, the logic level state is low. This condition applies to all pushbuttons except STROBE, MANUAL, AUTO, and EXT. Figure 6-2 functionally describes the MCU controls, indicators, and connectors related to an associated power source that is not equipped with an —08 Option.

6-9. OPERATING FEATURES

6-10. The following paragraphs describe operating features relating the MCU to power sources and should be read prior to operating the MCU.

6-11. Isolated Control Logic (—01 Option)

6-12. The MCU provides the digital input programming, including the STROBE pulse, necessary to test and control an associated 4200A power source equipped with an isolated control logic option (—01 Option) or with an inverted isolated control logic option (—08 Option). When using either option, a STROBE pulse is required to start the digital-to-analog conversion process after a valid digital input program is entered. In MANUAL mode, the STROBE pulse is generated by manual depression of the STROBE pushbutton. In AUTO/EXTERNAL REFERENCE mode, the STROBE pulse is generated automatically following a $1.5\mu s$ delay that terminates the last programmed bit. The STROBE pulse is 0.5μ sec wide with a minimum width of 500 ns. A negative slope (+5V to 0 transition) is required.

6-13. Direct Coupled Control Logic (—04 Option)

6-14. Power sources using the direct coupled control logic option do not require use of the STROBE pulse. When used in the AUTO mode the performance is limited by the timing format of the STROBE pulse. Ideally, the STROBE pulse should precede the input data change and last until the input data is settled. The STROBE pulse, however, occurs about $1.5\mu s$ after the change of input data and lasts about $0.5\mu s$. Consequently, voltage spikes may occur (going to 0 volts) when voltage levels are stepped. These spikes may be observed on an oscilloscope when monitoring the power source output and do not indicate a fault in the power source.

6-15. Coax Jack Cluster

6-16 Three BNC coaxial cable connectors located on the top panel of the MCU provide connections for test instruments. The common of these connectors is tied to logic ground.

6-17. Trigger Input

6-18. TRIGGER INPUT jack provides an input connection for an external trigger generator to produce a remote, manually controlled STROBE pulse when the MCU is in the AUTO EXT mode. The external trigger generator replaces a 10kHz multivibrator when the EXT pushbutton is depressed. An external 51Ω termination resistor is provided in the MCU for the external trigger generator. For optimum performance the trigger generator should have an output pulse impedance of 50Ω and be capable of producing the waveform shown in Figure 6-3.
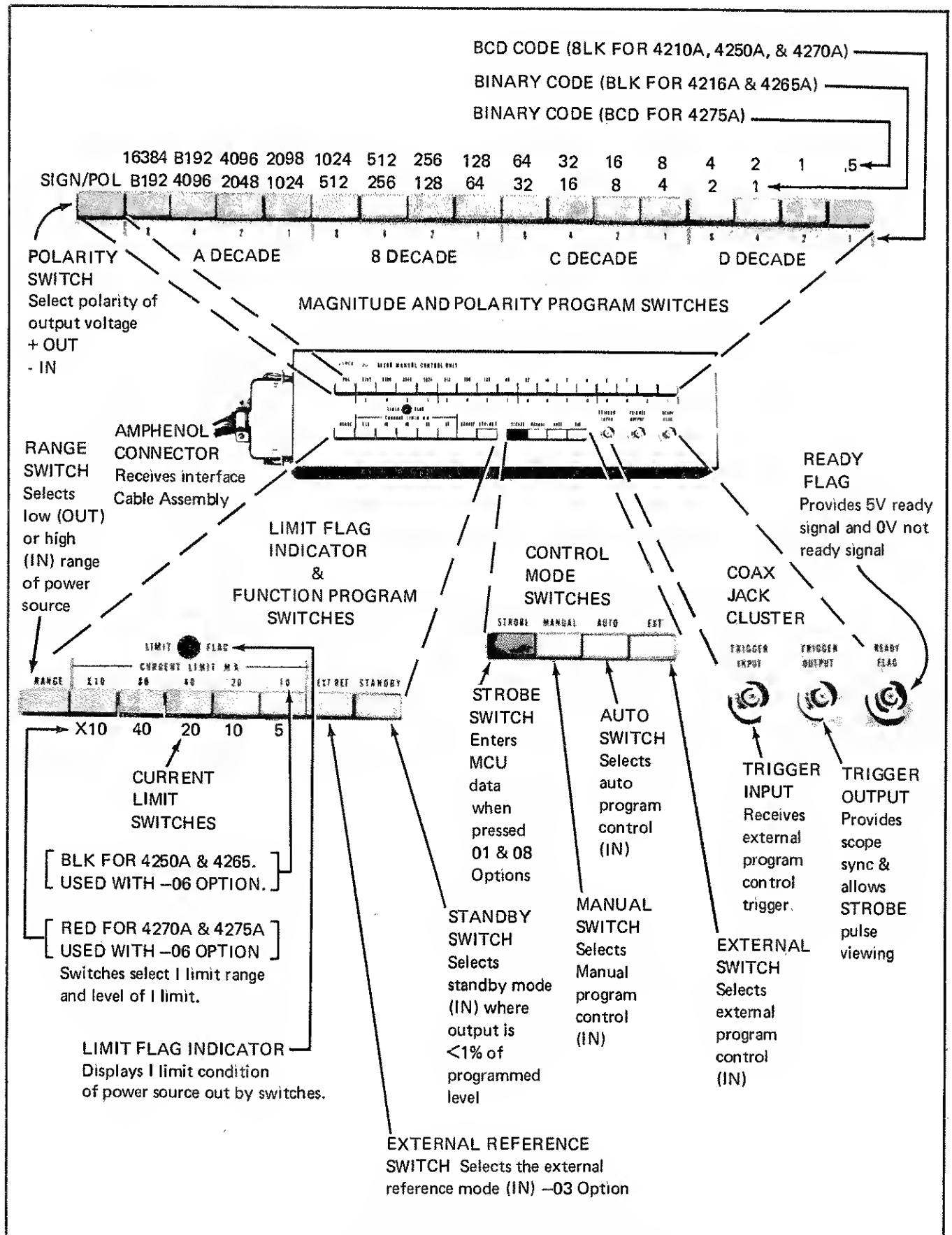
Figure 6-2 CONNECTORS, CONTROLS, AND INDICATORS

CAUTION

Application of trigger voltages higher than the recommended value will damage the MCU.

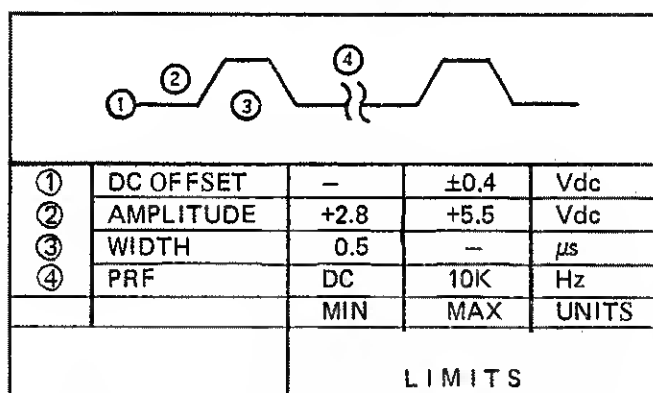|		MIN	MAX	UNITS
①	DC OFFSET	–	±0.4	Vdc
②	AMPLITUDE	+2.8	+5.5	Vdc
③	WIDTH	0.5	–	µs
④	PRF	DC	10K	Hz
		MIN	MAX	UNITS
			LIMITS	

Figure 6-3.   External Trigger Generator Requirements

6-19.   Trigger Output

6-20.   TRIGGER OUTPUT jack provides an output connection for monitoring the inverse of the MCU generated STROBE pulse. The output trigger is a positive-going pulse that occurs each time a STROBE pulse is generated. It is useful in synching a scope to the MANUAL-STROBE mode. However, when using the AUTO or EXT modes, which generate an automatic internal or external STROBE, the output trigger provides a valid scope sync for the ready or not ready flag output only. It cannot be used to monitor the power source output voltage in the AUTO or EXT modes.

6-21.   Ready Flag

6-22.   READY FLAG jack provides an output connection for monitoring the ready or not ready flag voltage. In the three control modes (MANUAL, AUTO, or EXT) the output trigger provides a valid scope sync for displaying the flag voltage.

6-23.   PROGRAMMING SWITCHES

6-24.   Of the twenty-nine program switches located on the MCU top panel, all but three are used to enter programming inputs into the 4200A series power sources. These three are AUTO, MANUAL, and EXT. Figure 6-2 divides these switches into three groups of control mode switches, magnitude and polarity program switches, and function program switches.

6-25.   Control Mode Switches

6-26.   The four control mode switches provide manual or automatic control of the manually selected input data program. MANUAL, AUTO, or EXT are the three control modes selectable on the MCU.

6-27.   Manual Mode

6-28.   The MANUAL mode allows manual manipulation of the input programming data as well as manual generation of the STROBE pulse. This mode is selected by depressing the Manual pushbutton. Each push of the STROBE pushbutton generates a 0.5µs STROBE pulse which transfers the previously selected manual program to the internal registers of the isolated control logic option (–01 Option). In the event the power source is equipped with a direct coupled control logic option (–04 Option) rather than the isolated control logic option, the power source output voltage changes as the program pushbuttons are pressed. No STROBE is necessary.

6-29.   Auto Mode

6-30.   The AUTO mode of operation provides automatic and sequential scanning of a previously selected magnitude program. The power source output is thusly stair-stepped or pulsed in a manually selected pattern, the sequence of which is governed by an internal 10kHz multivibrator. The multivibrator also initiates the STROBE pulse for the isolated control logic option. If a direct coupled control logic option is used in lieu of the isolated control logic option in the associated power source, then the timing of the STROBE is incorrect.

6-31.   External Mode

6-32.   EXT mode operation is similar to the auto mode of operation. The difference is that the internal 10kHz multivibrator is switched out and an external pulse generator is substituted at the TRIGGER INPUT jack. The sequence frequency is thereby remotely controlled by the trigger generator.

6-33.   Magnitude Program Switches

6-34.   Sixteen magnitude program switches provided on the MCU are used to program the BCD or binary magnitude inputs into an associated power source. Each pushbutton is labeled with one or more bit values depending upon unit serialization. Units bearing serial No. 224 and below are labeled entirely in black. Units bearing higher serial numbers are labeled in black and red. The red coding applies to (1) the binary magnitude used to program the 4275A power

source, and (2) to the current magnitude used to program the current limit option (when installed) in the 4270A and 4275A power sources. The black coding applies to both binary and BCD magnitude power sources with the location and format of the magnitude bits identifying related power source effectivity as follows: The black binary magnitude bits above the pushbuttons apply to the 4216A and 4265A power sources. The black BCD magnitude bits below the pushbuttons apply to the 4210A, 4250A, and 4270A power sources. In MANUAL mode the magnitude inputs are programmed directly by depressing a single or combination of magnitude pushbuttons. In AUTO mode an internal binary counter controls the manually selected magnitude inputs in a four-bit binary pattern. Each output of the binary counter is parallel connected to the four corresponding BCD or binary magnitude programming switches shown in Table 6-1. The power source input program is sequenced in a pattern that is determined by the selected magnitude program switches and the binary counter outputs. Figure 6-4 shows the power source output voltage patterns available by programming a single decade in the 4210A, the 4250A, or the 4270A power source.

6-35.   Polarity or Sign/Polarity

6-36.   The polarity program for the power sources is controlled by the program switch marked POL or SIGN/POL. Depressing this switch commands the negative programmed output voltage. The non-depressed or *out* position commands the positive programmed output voltage.

6-37.   External Reference

6-38.   The EXT REF switch, when depressed, programs the External Reference Option (−03 Option) of the 4200A series power sources.

6-39.   Standby

6-40.   The STANDBY switch, when depressed, programs the 4200A series power sources to the standby condition. This condition permits a single bit on a given control line to clear the output to about 1 percent of the programmed level without disturbing the previous command word. Upon returning to the operational condition by releasing the STANDBY pushbutton, the output reverts to the pre-programmed level.

6-41.   Range

6-42.   When the RANGE switch is depressed, the high range of the associated power source is programmed. When not depressed and in the *out* position, the RANGE switch programs the low range of the power source. The low and high ranges of the 4200A series power sources are given in Table 6-2.

6-43.   Current Limit

6-44.   The five CURRENT LIMIT MA switches labeled in black or in black and red numbers, depending upon serial No. effectivity, program the Programmable Current Limit Option (−06 Option) in the 4250A, 4265A, 4270A, and 4275A power sources. The black numbered pushbuttons are used with the 4250A and 4265A power sources and the red numbered pushbuttons are used with the 4270A and 4275A power sources. Pushbutton switches labeled in black enable selection of the desired current limit point in increments of 10mA low range or 100mA high range (X10) for the 4250A and 4265A power sources (Table 6-3). The red labeled pushbutton switches enable selection of the desired current limit point in increments of 5 mA low range or 50 mA high range (X10) for the 4270A and 4275A (Table 6-4). When none of the pushbuttons are depressed, the current limit is 10 percent of selected range; i.e., 10 mA and 100 mA for the 4250A and 4265A; 5 mA and 50 mA for the 4270A and 4275A. The 4210A and 4216A power sources do not utilize the programmable current limit

TABLE 6-1
PROGRAMMING SWITCHES CONTROLLED BY
THE BINARY COUNTER.

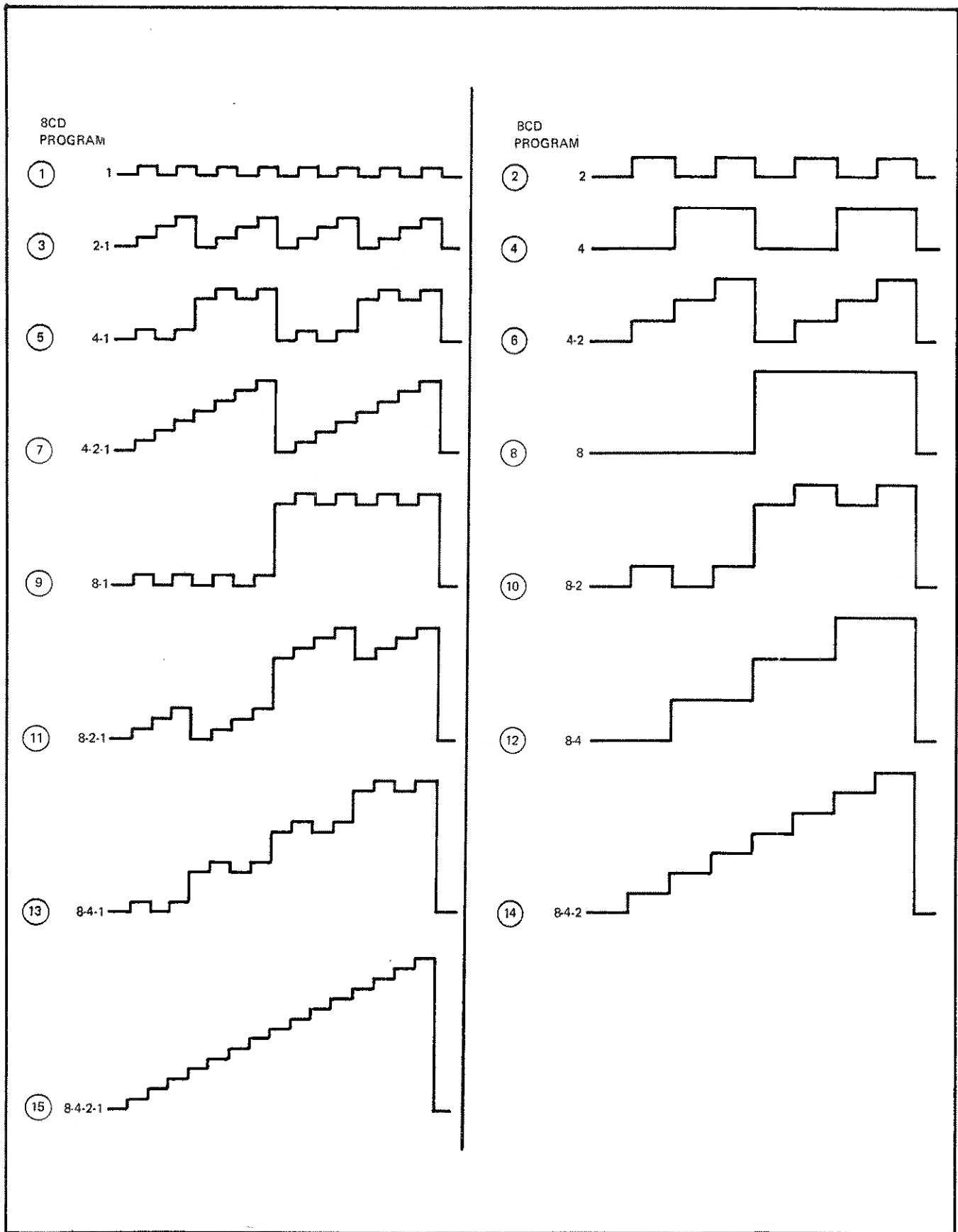| Binary Counter outputs	PROGRAMMING SWITCHES		
	4210A-4250A	4216A-4265A	4270A-4275A
1	1,1,1,1	4, 64,1024	.5, 8, 128, 2048
2	2,2,2,2	8,128,2048	1, 16, 256, 4096
4	4,4,4,4	1,16,256,4096	2, 32, 512, 8192
8	8,8,8,8	2,32,512,8192	4, 64, 1024, 16384

Figure 6-4. VOLTAGE PATTERNS OBTAINABLE BY DECADE PROGRAMMING
IN THE AUTO MODE (4210A, 4250A, AND 4270A)

TABLE 6-2.   4200A SERIES INSTRUMENT RANGES

RANGE		INSTRUMENT										
PUSH-BUTTON	STATE	4210A 4216A	4250A		50 VOLT RANGE INDICATOR	4265A	65 VOLT RANGE INDICATOR	4270A	110 VOLT RANGE INDICATOR	4275A	110 VOLT RANGE INDICATOR
OUT	LOW	16V	BCO 10V	BINARY 16V	OFF	16V	OFF	10V	OFF	32V	OFF
IN	HIGH	16V	65V	6SV	ON	6SV	ON	X10	ON	X4	ON

TABLE 6-3. CURRENT LIMIT PROGRAMMING WITH —06 OPTION

4250A ● 4265A CURRENT LIMIT MA PUSHBUTTON(S) DEPRESSED	RANGE (mA)	
	LOW	X10
NONE	10	100
10	10	100
20	20	200
20 ● 10	30	300
40	40	400
40 ● 10	50	500
40 ● 20	60	600
40 ● 20 ● 10	70	700
80	80	800
80 ● 10	90	900
80 ● 20	100	1000
INCREMENTAL CHANGE	10	100

● AND
CURRENT LIMIT WITHOUT —06 OPTION IS 1200mA

TABLE 6-4. CURRENT LIMIT PROGRAMMING WITH —06 OPTION

4270A ● 4275A CURRENT LIMIT MA PUSHBUTTON(S) DEPRESSED		RANGE (mA)	
RED	BLACK	LOW	X10
NONE	NONE	5	50
5	10	5	50
10	20	10	100
10 ● 5	20 ● 10	15	150
20	40	20	200
20 ● 5	40 ● 10	25	250
20 ● 10	40 ● 20	30	300
20 ● 10 ● 5	40 ● 20 ● 10	35	350
40	80	40	400
40 ● 5	80 ● 10	45	450
40 ● 10	80 ● 20	50	500
INCREMENTAL CHANGE		5	50

● AND
CURRENT LIMIT WITHOUT —06 OPTION IS 600mA

option, but do have a basic current limit of 100 mA. The basic current limit of the 4250A and 4265A power sources when not using the current limit option is 1.2 amp and, similarly, for the 4270A and 4275A is 0.6 amp.

6-45.   Front Panel Indicator

6-46.   The indicator labeled LIMIT FLAG on the MCU top panel is illuminated when a current overload (sink or source) condition occurs in the associated power source.

6-47.   THEORY OF OPERATION

6-48.   General

6-49.   The A4200 MCU contains manually controlled switching circuits, internal, fixed-frequency triggered switching circuits, and provisions for externally controlled, variable frequency triggered switching circuits that provide the logic signals to control an associated programmable power source. These switching circuits permit manual control of the power source output voltage as well as an automatically triggered, repetitive and manually variable program for controlling the power source output voltage. The MCU is also provided with input-output circuits that, with the aid of a supplemental scope, permit the visual presentation of the ready or not ready status of the power source, the trigger output signal, and a means of connecting an external trigger.

6-50.   Block Diagram Analysis

6-51.   A simplified block diagram of the MCU is shown in Figure 6-5. The primary function of the MCU is to pro-
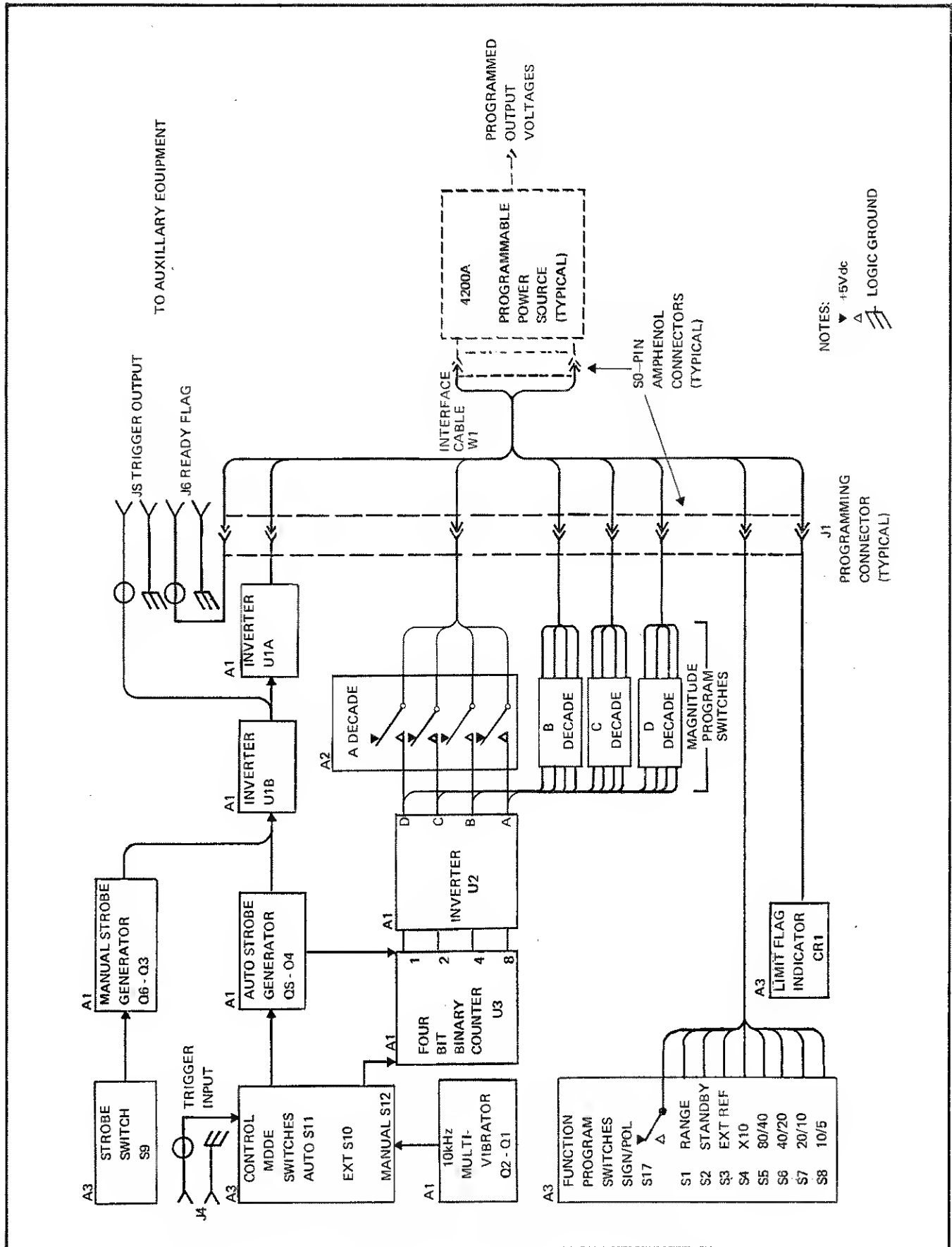
FIGURE 6-5.   A4200 MANUAL CONTROL UNIT BLOCK DIAGRAM

vide manual control of the programming inputs into the 4200A series power sources. Switching by the following groupings of switches accomplishes this purpose: control groupings of switches accomplishes this purpose: control mode switches, magnitude program switches, and function program switches. The secondary function of the MCU is to provide an automatic mode of operation that applies a manually selected and manually variable magnitude program repetitively at a fixed or variable rate to a power source. This is accomplished by the following: a 10kHz oscillator, the control mode switches, and a 4-bit binary counter. The manual and auto strobe generators provide control of the strobing pulse for both the manual and automatic modes of operation.

6-52.   With manual mode selected by A3 control mode switch S12, the four-bit counter is supplied with a logic 0 (low). This sets all four outputs of the counter to a logic 1 (high). Inverter U2 reverses the logic 1 on all four counter output lines to a logic 0, and then applies them in parallel through all closed magnitude program switches to the programmable power source via the interface cable and programming connectors. However, before the power source can act on the logic levels present on each of the 16 data lines, a logic level 0 manual strobe pulse must be entered. This is accomplished by manual depression of the strobe pushbutton switch S9, applying a logic 1 to the manual strobe generator Q6-Q3, which, in turn, supplies a logic 0

to inverter U1B. The dual inversion of inverters U1B and U1A then supplies the programmable power source with a logic 0 and the programmed output voltage appears at the output of the power source when the power source is equipped with the isolated control logic option.

6-53.   With auto mode selected by A3 control mode switch S11, the previously selected manual mode switch is disconnected through interlock action. This removes the logic 0 applied to the set lines of binary counter U3. Simultaneously, the 10kHz multivibrator output is applied to two places: to the clock input of binary counter U3 and to the input of the auto strobe generator, Q5-Q4. The 10kHz multivibrator input to the binary counter U3 clocks it low initially and triggers the repetitive waveform pattern shown in Figure 6-6. The multivibrator input to auto strobe generator Q5-Q4 produces a 10kHz strobe pulse at its output, approximately half a microsecond wide, that is negative going, descending from +5 to 0Vdc. The pulse is inverted once through inverter U1B, to be used as a trigger output pulse at J5, and is inverted a second time through · inverter U1A to be applied to the programmable power source via the interface cable W1 and programming connectors. The sequential output of the 10kHz driven binary counter is applied to the power source through any closed magnitude program switch in each decade following inversion through inverter U2.
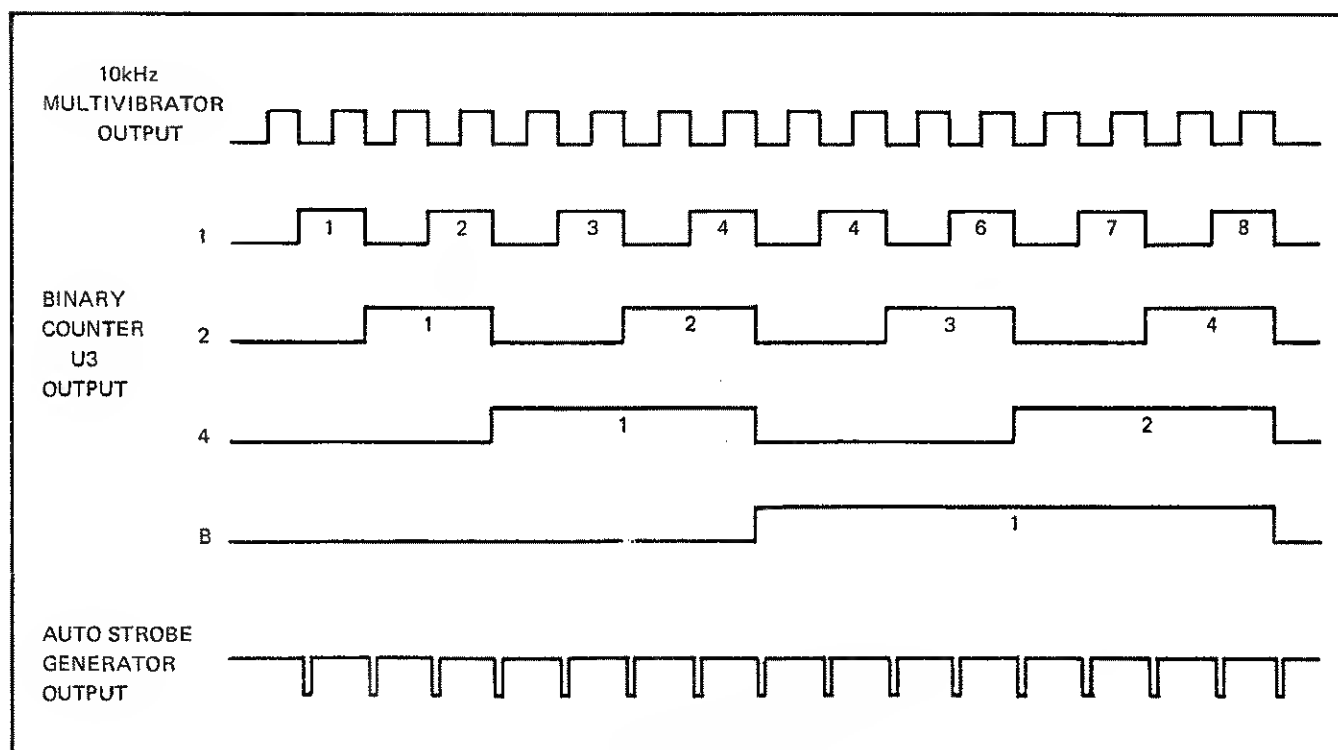

FIGURE 6-6.   MODEL A4200 MCU TIMING DIAGRAM

6-54. With external mode selected by the A3 control mode switch, S10, the previously selected auto mode switch is disconnected through interlock action. This removes the 10kHz multivibrator output from the input to the binary counter and from the input to the auto strobe generator. Switched into these two input circuits is trigger input jack J4. Hence, use of an externally controllable trigger generator is possible, providing the parameters are generally as follows: output pulse frequency of 10kHz, 0.5μs pulse width, and having an output pulse impedance of about 50 ohms. The external trigger generator substitutes for the internal 10kHz multivibrator in the external mode, and circuit activity is essentially the same as discussed in auto mode.

6-55. The A3 function program switches provide a logic level low signal on the appropriate line to the connected power source when a given function switch is depressed. The SIGN/POL switch, S17, is shown as an example typical of these switches.

6-56. The indicator light LIMIT FLAG on the MCU top panel is essentially a duplication of the I LIMIT indicator on the front panel of a 4200A series power source. Hence, these two indicators can be expected to illuminate together when a specified current limit point is reached.

6-57. Circuit Description

6-58. The following paragraphs briefly describe the circuitry in the MCU. Each description, unless otherwise noted, is referenced to the schematic diagram A4200-1000 located at the end of this section.

6-59. CONTROL MODE SWITCHES. The control mode switches consist of three single pole, double-throw switches on the A3 Function Assembly, S10 through S12. These switches are the ganged, interlock, pushbutton type and only one switch at a time can be closed and latched. Switch S12, the MANUAL mode switch, when depressed and latched, applies a logic low (0 volts) to the four set input lines of the four-bit binary counter U3, pins 3,5,10, and 12. This forces the counter outputs on pins 4,6,9, and 11 to a logic high (5 volts). When the AUTO mode switch S11 is depressed and latched, the MANUAL mode switch is interlock released to its non-depressed state. This applies 5 volts to the binary counter previously held low by the latched, but now released MANUAL mode switch, and permits the counter to be advanced by the 10kHz multivibrator input at pin 1 of U3. The 10kHz MV output, supplied to the counter through the closed contacts of switch S11, is also applied to the input of the auto strobe generator at pin 9 of U1D. When the EXT mode switch S10 is depressed and latched, the AUTO mode switch is released. This removes the

10kHz MV output from the input of the auto strobe generator and from the clock input of the binary counter. The closed EXT mode switch connects the TRIGGER INPUT jack J4 to the counter and strobe generator inputs. An external 50 ohm pulse generator can be used to replace the 10kHz MV pulse. A 51 ohm resistor R1, provides the input termination for the external generator.

6-60. MAGNITUDE PROGRAM SWITCHES

6-61. The magnitude program switches consist of sixteen single pole, double-throw, push-push switches on the A2 Program Assembly, S1 through S16. The arms of these switches are wired directly to pins 1 through 16 of the J1 programming connector. The normally closed contacts of these switches are bussed to the 5Vdc power input, pin 25 of the programming connector. Hence, in their normally closed condition, which is the non-depressed state, these switches apply 5Vdc to pins 1 through 16 of the programming connector.

6-62. The normally open contacts of the switches are bussed in fours to one switch each in each of four groups, as S1 to S5 to S9 to S13, as S2 to S6, to S10, to S14, etc. In one case, these switches can be considered to be bussed in four BCD groups as determined by the weighting assigned each switch; i.e., 8, 4, 2, and 1. Thus, in the four decades, all similar weighted switches are paralleled on their normally open contacts.

6-63. Binary counter U3 supplies 1-2-4-8 logic levels through inverting gates U2D through A to the 1-2-4-8 switch busses, respectively. The logic levels are dependent on the state of the binary counter. In manual mode, the outputs of U3 are forced high (5 volts). Therefore, the outputs of the inventory gates supply a low (0 volts) to the switch busses. However, in auto or external mode, the switch busses are switched between high and low in a binary sequence and at a frequency determined by the 10kHz multivibrator, or by an external frequency applied at the trigger input jack J4.

6-64. FOUR-BIT BINARY COUNTER

6-65. The four-bit binary counter U3 is an asynchronous negative-edge triggered counter. The outputs (1-2-4-8) of the counter are connected to the correspondingly weighted busses of the sixteen magnitude program switches through the inverting gates of U2. The outputs of the counter are low at zero and go high in binary sequence. The clock required to advance the counter is supplied through the control mode switches by the 10kHz multivibrator, or by an

external pulse generator connected to trigger input jack J4.

6-66.   TEN KILOHERTZ MULTIVIBRATOR

6-67.   The 10kHz multivibrator is a simple, dual transistor (Q1-Q2) multivibrator designed to free run at approximately 10kHz. The square wave output is used in the auto control mode to clock the binary counter and to trigger the auto strobe generator.

6-68.   AUTO STROBE GENERATOR

6-69.   The A1 auto strobe generator is composed of transistors Q4-Q5 and inverter amplifiers U1A through U1E, plus related circuit components. It is an active pulse shaping network that is used to supply a strobe pulse in the auto and external modes of MCU operation. The negative descent of each 10kHz pulse from the 10kHz MV triggers the auto strobe generator. Following an approximate delay of 1.5 microseconds, a strobe pulse of half a microsecond, approaching 0 volts from a 5 Vdc reference, is produced at the input of inverter amp U1B. The output of U1B produces a positive-going pulse that is applied as a trigger at trigger output jack J5. Inverter amp U1A returns the strobe pulse to its original excursion and presents it at pin 33 of the programming connector.

6-70.   MANUAL STROBE GENERATOR

6-71.   The A1 manual strobe generator is composed of transistors Q6 - Q3, A3 control mode switch S9 (STROBE), and related circuit components. The manual strobe pulse generator is built around a programmable unijunction transistor (PUT) Q6 which is effectively anode gated by the application of a positive voltage through the momentary closed contacts of the STROBE pushbutton switch S9. The firing of Q6 turns on gating transistor Q3, which effectively applies a logic 0 pulse at the input of inverter amp U1B. Pulse processing through the two inverters, U1B and U1A, is the same as described in the previous paragraph.

6-72.   FUNCTION PROGRAM SWITCHES

6-73.   The function program switches consist of nine spot push-push switches (with one exception - the momentary contact STROBE switch S9) on the A3 Function Assembly, S1 through S9. The arms of these switches are wired directly to their corresponding pins on the J1 programming connector. These switches are independent and are not controlled by any other switches or any other circuitry, with the exception of the 5 volt 1ns line which is paralleled to the normally closed contacts of switches S1

through S8. Switch S9 is the opposite configuration with the 5 volt bus line tied to the normally open momentary contact. Switches S1 through S8, when depressed, latch to logic 0.

6-74.   READY FLAG

6-75.   Ready flag connector J6, mounted on the MCU top panel, produces an output of 5Vdc to indicate that the related power source is ready to accept programming inputs, or produces a 0 volt output to indicate that the power source is not ready to accept programming inputs. This output jack is tied directly to the power source through the interface cable and programming connectors on Pin 37.

6-76.   LIMIT FLAG

6-77.   Limit flag indicator CR1, mounted on the MCU top panel, is a red-light emitting diode. It illuminates when forward biased by a logic 1 (logic ground) on its cathode. A logic 1 is applied to the cathode from the programmable power source via the interface cable and programming connectors on Pin 49 when an overload (overcurrent) condition exists in the power source.

6-78.   MAINTENANCE

6-79.   Introduction

6-80.   The maintenance procedures given in the following paragraphs describe maintenance access, pushbutton replacement, LIMIT FLAG indicator replacement, and troubleshooting.

6-81.   Maintenance Access

6-82.   Remove six Phillips Head screws from sides of channel bottom. Remove four Phillips Head screws securing rubber feet to bottom of unit.

6-83.   Withdraw V-shaped channel bottom from MCU. Test points 1 through 5 are now accessible at bottom of unit on the component side of the motherboard, connector PCB Assembly.

6-84.   Remove two Phillips Head screws from rear, left side of unit.

6-85.   Remove motherboard, Connector PCB Assembly from the unit with a gentle rocking and pulling motion to separate motherboard from the two other PCB's in the unit.

6-86. Disconnect coaxial jack cluster connectors at the underside of the Function Assembly PCB. These four connectors may be colored BLK, RED, BRN and ORN.

6-87. Disconnect leads to LIMIT FLAG light emitting diode - also on the same PCB. These two leads may be colored ORN and YEL.

6-88. Remove two Phillips Head screws from the right side of the unit and two remaining screws from the left side of the unit.

6-89. Remove the switch panel from the MCU top panel. Each of the individual pushbutton switches are accessible for individual continuity checks. The upper switch bank is mounted on the Program PCB Assembly and the lower switch bank is mounted on the Function PCB Assembly. Prior to further disassembly, note the relationship of the program PCB and function PCB to the end flanges of the MCU top panel. Viewed from the rear, with program PCB uppermost, the cluster of four P-nuts must be on the right flange.

6-90. Removal of two Phillips Head screws from each of the ends of the program and function PCB's permit removal of these two boards with attached pushbutton switch banks.

6-91. Assembly of the MCU is done in reverse order of disassembly with attention to the proper locating of the program and function PCB's on the switch panel as noted in step 6-89. Reversal of these two PCB's is possible, but will not permit final assembly of the top panel.

6-92. Switch Maintenance

6-93. The following eleven paragraphs describe the procedure to be followed when a defective switch is to be replaced in the MCU.

6-94. Remove the PCB assembly that contains the defective switch using the maintenance access procedures given in the previous paragraphs.

6-95. Since individual pushbutton switches are not replaceable, an entire switch set that contains the defective switch must be replaced as a unit.

6-96. Refer to the List of Replaceable Parts to determine the FLUKE part number for the switch set to be replaced and order the switch set in conformance with part ordering instructions.

6-97. Following receipt of the correct replacement

switch set, determine that it is operating correctly and then remove the switch set containing the defective switch as follows:

a. Using a small soldering iron and a solder removing tool, unsolder all of the switch set mounting tabs from the circuit board pads and remove as much liquified solder as possible with the solder removing tool.

b. Prevent adherence of the cooling tabs to the pads by vibrating each tab in its pad with a pair of needlenose pliers or a similar tool.

c. After all tabs are unsoldered from the PCB pads, remove the entire switch set from the PCB and exercise care to remove the PCB spacers that are attached to the switch tabs. Make a layout sketch of the positions of the spacers on the switch set.

d. Remove the spacers from the defective switch set and install them, each one on the new switch set in accordance with the layout sketch made in the previous step. Press the spacers tightly against the switches, cleaning out any flowed solder that prevents full surface contact between the spacers, switches, and PCB.

e. Insert the new switch set into the PCB in the same orientation as the adjacent switch set, top side up.

f. Solder all tabs into the PCB pads and be careful to press each switch tightly against the PCB. The installed switch set must be aligned with the adjacent switch set and with the PCB evenly, or else the switch assembly will not fit through the slots on the top panel at final assembly.

g. Check that the newly installed switch set is operating correctly and install the PCB into the MCU as defined under maintenance access.

6-98. Limit Flag Indicator Replacement

6-99. The following eleven paragraphs describe the procedure to be followed when a defective indicator is to be replaced in the MCU.

6-100. Refer to the List of Replaceable Parts to determine the FLUKE part number for the indicator to be replaced and order it in conformance with the part ordering instructions.

6-101. Install replacement indicator in the MCU as follows:

a. Perform maintenance access procedures to the step that removes the motherboard connector PCB Assembly from the MCU.

b. Locate insulating sleeving that covers one of the wires leading into the rear of the defective indicator and slide it back along the wire until the amp connector it covers is fully exposed. Observe color coding of wires for later hook-up.

c. With a long pointed soldering tool, unsolder the amp connector uncovered in the previous step from an indicator lead. Repeat with the other indicator lead and clean both amp connectors internally of any residual solder.

d. Using a blunt instrument or rod of sufficient diameter to clear the inside of the indicator retaining cup, push the indicator out the retaining cup from the rear. Observe orientation upon removal for later installation of replacement.

e. Using the removed indicator as a guide for the new indicator, clip the correct lead at the base and the other two leads to the proper length.

f. Insert the indicator into the cup in the same exact orientation as observed during removal of the defective indicator.

g. Connect both amp connectors identically to the earlier observed hook-up and solder connectors to the indicator leads using minimal heat and solder.

h. Slide the insulating sleeving over the amp connector to insulate the bare indicator leads from each other.

i. Assemble the MCU in accordance with procedures given under maintenance access.

6-102. TROUBLESHOOTING

6-103. The troubleshooting of an improperly responding and defective power source, when under control of an MCU, is not covered in this section. Troubleshooting the power source is covered, however, in the basic instrument maintenance section of the manual, and may not include use of the MCU as a troubleshooting aid. On the other hand, the first indication that troubleshooting is necessary will be an improperly responding power source that is under control of an MCU. Consequently, the first step in using these troubleshooting procedures is to determine that the MCU is faulty and not the associated power source.

6-104. The MCU and power source are tied together for one of three purposes: (1) for manual control of the programming inputs to a valid power source, (2) for calibration and adjustment of an out-of-tolerance or repaired power source, and (3) for troubleshooting an improperly operating power source. In the first two cases when malfunctions are observed in the response of the power source to MCU programming inputs, other than obvious mechanical faults on the MCU, such as a stuck switch, a bent or misaligned programming connector, or a servered cable wire - all of which are readily identified and repaired - isolation of the fault to the MCU is accomplished by disconnecting the MCU at the power source programming connector and connecting another programming source, known to be good, to the power source. In the third case where an MCU is used to troubleshoot an improperly operating power source and the MCU becomes suspect, the MCU must be considered defective and checked separately. A troubleshooting procedural outline is given on the reverse side of the foldout page which faces the schematic diagram of the MCU.

6-105. Equipment required for troubleshooting the MCU is a multimeter, an oscilloscope, and a 7-inch insulated shorting jumper terminated with midget alligator clips. Additionally, a 5 volt dc power supply is required for troubleshooting the MCU when it is disconnected from the power source.

6-106. With the interface cable attached and locked to the J1 programming connector on the MCU, gain access to the motherboard A1 Connector Assembly and locate test points 1 through 5. See maintenance access procedures, paragraph 6-81. Proceed with troubleshooting procedures given on drawing No. A4200-1800.

MODEL A4200

TROUBLESHOOTING PROCEDURES

Power Off Checks

1. Inspect MCU for improperly seated plug-in assemblies, loose or broken wires, damaged or burned components, or other obvious problems.

2. Check that switches are aligned and that no broken switch return springs are evident.

3. Check that connectors are properly attached to motherboard A1 Connector Assembly from coaxial jacks and from LIMIT FLAG indicator.

Power on Checks

1. Apply 5 Vdc to MCU in either of two ways to determine that power input and distribution circuits are continuous. Either apply power by connecting interface cable connector to power source and turning on power switch, or by locating test points 4 (+) and 3 (-) and applying +5Vdc to these test points from the and applying +5Vdc to these test points from the 5Vdc power supply.

2. If MCU is connected to a power source as defined above, check for +5Vdc between test points 4 (+) and 3 (-). If MCU is connected to the 5Vdc power supply at test points 4 (+) and 3 (-), check for +5Vdc between pin 25 (+) and any pin of the group number 17 through 24 (-) on the unconnected interface cable connector.

3. Failure to measure the required voltage at the places specified above indicates a defective interface cable/ connectors or a defective A1 motherboard A1 Connector PCB Assembly. Refer to the schematic diagram and localize the fault to either the interface cable/ connectors or to the A1 PCB, as appropriate.

    10kHz MULTIVIBRATOR CHECK. Check the output of the 10kHz multivibrator by measuring between test points 1 (+) and 3 (-) either with a multimeter set to 2.5Vdc for full scale deflection, or, if a waveform inspection is desired, connect the input of the scope to these test points and observe the square wave output as shown in Figure 6-6. If neither voltage nor waveform is present, the multivibrator may be locked up. In this case, remove power from the MCU and reapply as a step function to initiate flip-flop action of the multivibrator. Check output again, and, if

none is observed, the multivibrator circuit is defective.

MANUAL SWITCH, FOUR-BIT BINARY COUNTER, AND GATED INVERTER U2. Locate pins 9 through 12 on the rear of the interface cable connector attached to the A1 motherboard. Select one of the four pins for +5Vdc full scale deflection measurement on the meter. Use test point 3 (-) for ground reference. Depress and latch the C decade pushbuttons. Depress and latch the MANUAL pushbutton and check that the multimeter reads about 0Vdc. Check for 0Vdc on the other three pins. Release MANUAL and check that the multimeter reads +5Vdc on each pin. Failure to read any one voltage indicates that inverter U2 is probably defective. Failure to read all voltages indicates that the four-bit binary counter or MANUAL switch is probably defective. To isolate the MANUAL switch from the counter, proceed as follows: Confirm that 5Vdc exists on pin 9 at the rear of the interface cable connector attached to the A1 motherboard. Attach the shorting jumper between test points 1 and 2 and check that the multimeter reads less than the previous dc voltage. If less, then the MANUAL switch is probably defective. If dc voltage does not decrease after the shorting jumper is attached then the four-bit counter is defective. This condition can be confirmed by viewing absence of waveform on scope at pin 9 after the shorting jumper is attached.

STROBE SWITCH, MANUAL STROBE GENERA-TOR, AND INVERTERS U1A–U1B. Connect oscilloscope input between pin 33 and test point 3. Set up scope for display of 0.5μs pulse (s) descending to 0 from +5Vdc. Depress STROBE pushbutton switch repeatedly and observe more than one decending pulse of the extent and magnitude given above. If no pulse is obtained, repeatedly attach shorting jumper between test points 4 and 5 and check scope for pulses. If pulses are obtained, STROBE switch is defective. If no pulses, take scope input from TRIGGER OUTPUT jack J5, and look for ascending pulses. If pulses are obtained, integrated circuit inverter U1A is defective. If no pulses are obtained either the manual strobe generator or the auto strobe generator is defective. To check the auto strobe generator, remove the previously attached shorting jumper and attach it between test points 1 and 2. Check for previously defined output pulse(s) from TRIGGER OUTPUT jack J5. If pulses are present, manual strobe generator is defective. If pulses absent, integrated circuit inverter U1B, which is part of the auto strobe generator, is defective.

AUTO STROBE GENERATOR AND AUTO SWITCH: The previous paragraph defined the procedures for checking part of the autostrobe generator that is common to the manual strobe generator. This paragraph gives the procedure for checking that portion of the auto strobe generator upstream of inverter U1B as well. Set up the scope as defined in first two sentences of the previous paragraph. Remove shorting jumper from test points 1 and 2 if previously attached. Depress and latch AUTO pushbutton on top panel of MCU. Check for repeated pulses as defined above. If pulses are present, the circuitry from the 10kHz multivibrator to AUTO switch to auto strobe generator to output at pin 33 is valid. If pulses are not present, determine from a previous paragraph that 10kHz multivibrator is valid and then apply the shorting jumper between test points 1 and 2. If pulses are present, the AUTO switch is defective. If pulses are absent, the auto strobe generator is defective. To determine which pulse forming stage in the pulse generator is defective, refer to the schematic and, using the scope, check each stage regressively from the base circuit of transistor Q4 until a waveform synched to 10kHz is found. This point defines the input to the defective stage.

SWITCHES AND INDICATOR: Troubleshooting of the pushbutton switches and indicator is done using a multimeter for either continuity or volrage checks.
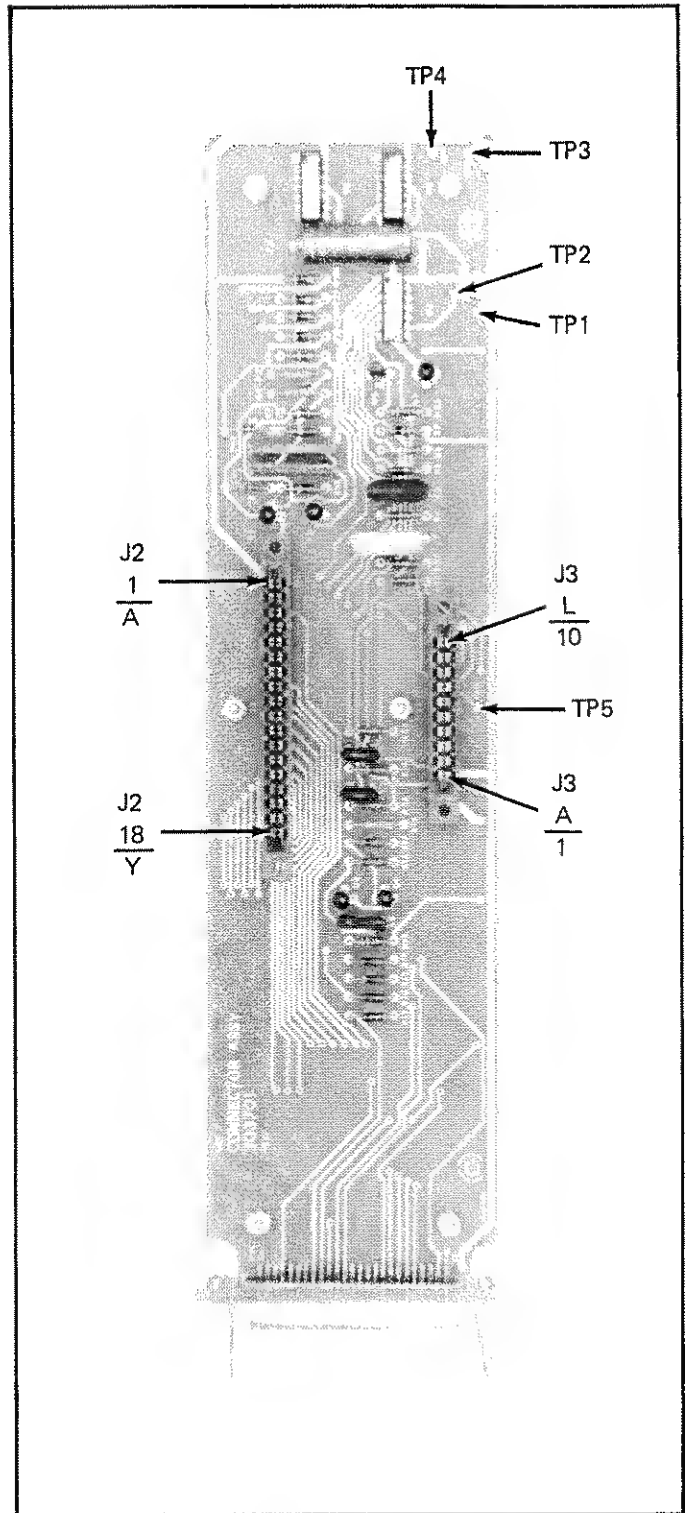
Figure 6-7. MOTHER BOARD A1
CONNECTOR ASSEMBLY PCB

TROUBLESHOOTING PROCEDURES
DRAWING NO. A4200—1800

6-107.   LIST OF REPLACEABLE PARTS

6-108.   For column entry explanations, part ordering in-
formation and basic instrument configuration Use Codes
and Serial Number Effectivity List, see Section 5.   See
paragraph 6-109, this option subsection, for additional Use
Codes and Serial Number Effectivity List assigned to this
printed circuit assembly option.

6-109.   SERIAL NUMBER EFFECTIVITY

6-110.   A Use Code column is provided to identify certain
parts that have been added, deleted, or modified during
production of the Model A4200.   Each part in this option
for which a use code has been assigned may be identified
with a particular serial number by consulting the Use Code
Effectivity List below.   All parts with no code are used on
all serial numbers 123 and on.   NOTE: These Use Codes
and Serial Number Effectivity apply to this option only.

USE
CODE   SERIAL NUMBER EFFECTIVITY

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
	MANUAL CONTROL UNIT (Figure 6—8)	A4200			
A1	CONNECTOR ASSEMBLY, PCB Figure 6-9.	303701	1		
A2	PROGRAM SWITCH ASSEMBLY, PCB Figure 6-10.	303727	1		
A3	FUNCTION ASSEMBLY, SWITCH PCB Figure 6-11.	303719	1		
	PANEL, TOP, SCREENED Figure 6-8.	303743	1		
	Connector, BNC, level cont. input.	152033	3		
CR1	Diode, Light Emitting	309617	1		
W1	Cable Assembly, Interface	303354	1		
XCR1	Clip, Snap-in, (diode) black Panel Switch (	309625	1		
	Panel Switch (interior)	303768	1		
	Foot, Rubber Button, black	130138	4		
	Channel, bottom	303750	1		
	Switch Assemblies (see A2/Figure 6-9. and A3/Figure 6-10.)				

Figure 6-8   MANUAL CONTROL UNIT

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
A1	**CONNECTOR ASSEMBLY, PCB** **Figure 6—9.**	REF			
C1,C2	Cap, fxd flm, .0047 uf ±2% 150v	182972	2		
C3	Cap, plstc .047 uf ±10%, 200v	207555	1		
C4	Cap, mica, 330 pf ±5%, 500v	148445	1		
C5	Cap, mica, 100 pf ±5%, 500v	148494	1		
C6	Cap, fxd, elect, 640 uf + 50/−10%, 6.4v	178608	1		
C7	Cap, plstc, .47 uf ±10%, 250v	184366	1		
C8	Cap, mica, 640 pf ± 5%, 500v	215251	1		
CR1,CR2	Diode, sil, 150 ma	203323	2		
J1	Connector, female, 50 contact	267252	1		
J2	Connector, female, 36 contact	285247	1		
J3	Connector, female, 20 contact	292912	1		
Q1 thru Q5	Xstr, Si, NPN	159855	5		
Q6	Xstr, Si, unijunction	268110	1		
R1,R4,R28, R29	Res, comp, 2.4K ±5%, 1/4w	193433	4		
R2,R3	Res, met flm 15.4K ±1%, 1/8w	261651	2		
R5	Not used				
R6	Res, comp, 22K ±5%, 1/4w	148130	1		
R7	Res, comp, 10K ±5%, 1/4w	148106	1		
R8	Res, comp, 39K ±5%, 1/4w	188466	1		
R9	Res, comp, 15Ω ±5%, 1/4w	147876	1		
R10,R11,R17	Res, comp, 1K	148023	3		
R12,R14,R19 thru R22	Res, comp, 3K ±5%, 1/4w	193508	6		
R13	Res, met flm, 13.7K ±1%, 1/8w	236752	1		
R15,R23,R26	Res, comp, 510Ω ±5%, 1/4w	218032	1		
R16,R18,R25	Res, comp, 390Ω ±5%, 1/4w	147975	3		
R24	Res, comp, 2.7Ω ±5%, 1/4w	246744	1		
R27	Res, comp, 270Ω ±5%, 1/4w	160804	1		

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
U1	I.C., TTL, Hex inverter, Buffer/Driver	288605	1		
U2	I.C., DTL, Quad 2—Input NAND Gate	268375	1		
U3	I.C., DTL, Binary Counter	267153	1		
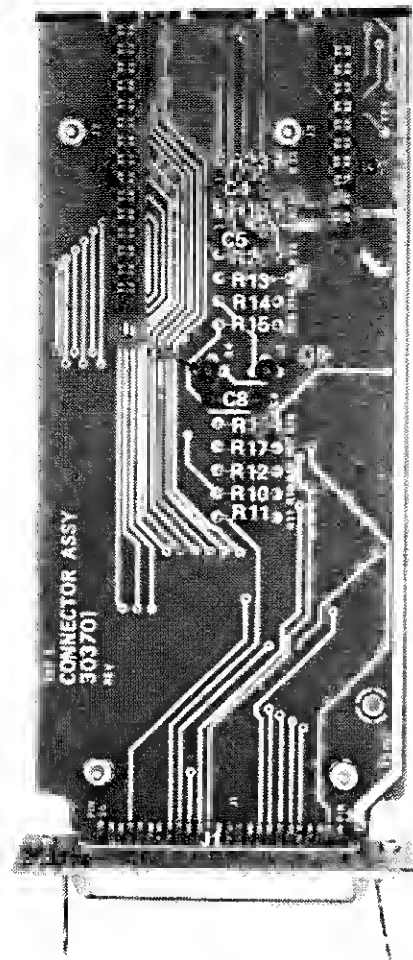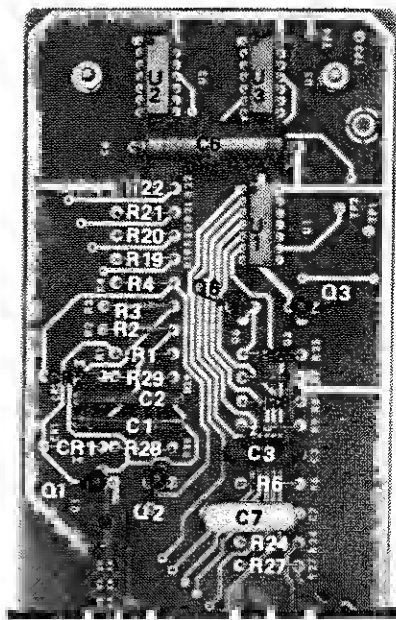
Figure 6-9.   CONNECTOR ASSEMBLY PCB (A4200-4001)

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
A2	**PROGRAM ASSEMBLY** **Figure 6—10.**	REF			
S1 thru S8	Switch Assembly (8 pushbutton)	306589	1		
S9 thru S17	Switch Assembly (9 pushbutton)	306571	1		

Figure 6-10.   PROGRAM ASSEMBLY

REF DESIG	DESCRIPTION	STOCK NO	TOT QTY	REC QTY	USE CODE
A3	**FUNCTION ASSEMBLY PCB** **Figure 6—11.**	REF			
R1	Res, comp, 51Ω ±5%, 1/4w	221879	1		
S1 thru S8	Switch Assembly (8 pushbutton)	306589	1		
S9 thru S12	Switch Assembly (4 pushbutton)	306597	1		
	Connector pin	267500	6		
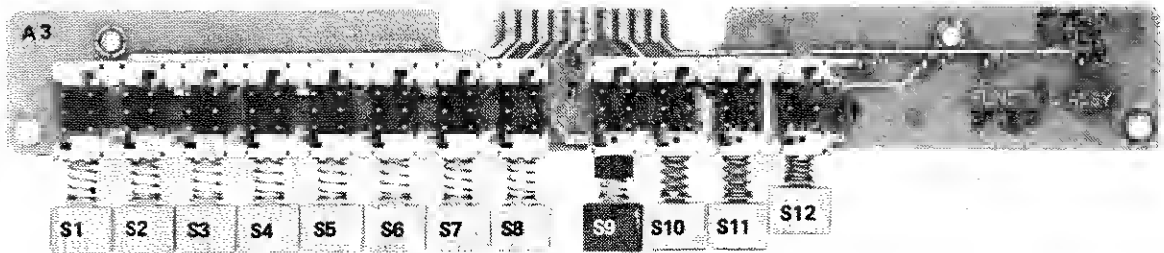
Figure 6-11.   FUNCTION ASSEMBLY

MANUFACTURERS' CROSS REFERENCE LIST					
FLUKE STOCK NO.	MFR.	MFR. PART NO.	FLUKE STOCK NO.	MFR.	MFR. PART NO.
130138	70485	366	268375	04713	MC846P
147876	01121	CB1505	285247	02660	225-21821-110
147975	01121	CB3915	288605	01295	SN7416N
148023	01121	CB1025	292912	02660	225—21021—110
148106	01121	CB1035	303354	89536	303354
148130	01121	CB2235	303701	89536	303701
148445	14655	CD15F330J	303743	89536	303743
148494	14655	CD15F101J	303750	89536	303750
152033	02660	UG1094A/U	303719	89536	303719
159855	07910	CS23030	303727	89536	303727
160804	01121	CB2715	303768	89536	303768
178608	73445	C437ARC640	306571	89536	306571
182972	02799	PE—472—G	306597	89536	306597
184366	73445	C280AE/A470K	306589	89536	306589
188466	01121	CB3935	309617	71318	FLV102
193433	01121	CB2425	309625	07263	FVC 001T
193508	01121	CB3025			
203323	03508	DHD1105			
207555	14655	DMF2S47			
215251	14655	CD19F641J			
218032	01121	CB5115			
221879	01121	CB5105			
236752	91637	Type MFF 1/8			
246744	01121	CB27G5			
261651	91637	Type MFF 1/8			
267153	04713	MC839P—6921			
267252	02660	57—40500			
267500	00779	86144—2			
268110	03508	D13T1			

Accessory
Rack Mounting Fixtures

6-1.   INTRODUCTION

6-2.   The Accessory Rack Mounting Kits are of two general types: half-rack width and full-rack width. The half-rack width mountings are further divided into dual mountings, center mountings, and offset mountings. Chassis Slide Kits, which enable withdrawl of the rack mounted instrument for inspection and servicing, can be installed on full-width rack instruments and on half-rack width instruments when in the dual mounting configuration. Figure 6-1 shows the variations possible in rack mountings and the configurations which can use chassis slides, all variations related to the standard 19-inch equipment rack.

6-3.   INSTALLATION PROCEDURES

6-4.   Half-Rack Width Mountings

6-5.   The half-rack width mountings are shown in Figure 6-1 as A, B, and C. The full-rack mounting is shown as D. To install the mountings shown in Figure 6-1 B through D, proceed as follows:

a.   Disconnect the line power cord.

b.   Peel the decal shown in Figure 6-2 from each front side panel.

c.   Install the mounting brackets on each front side panel using the #8-32 x 1/2" PHP screws provided in the kit. The mounting brackets for offset installation can be installed on either side, as desired.
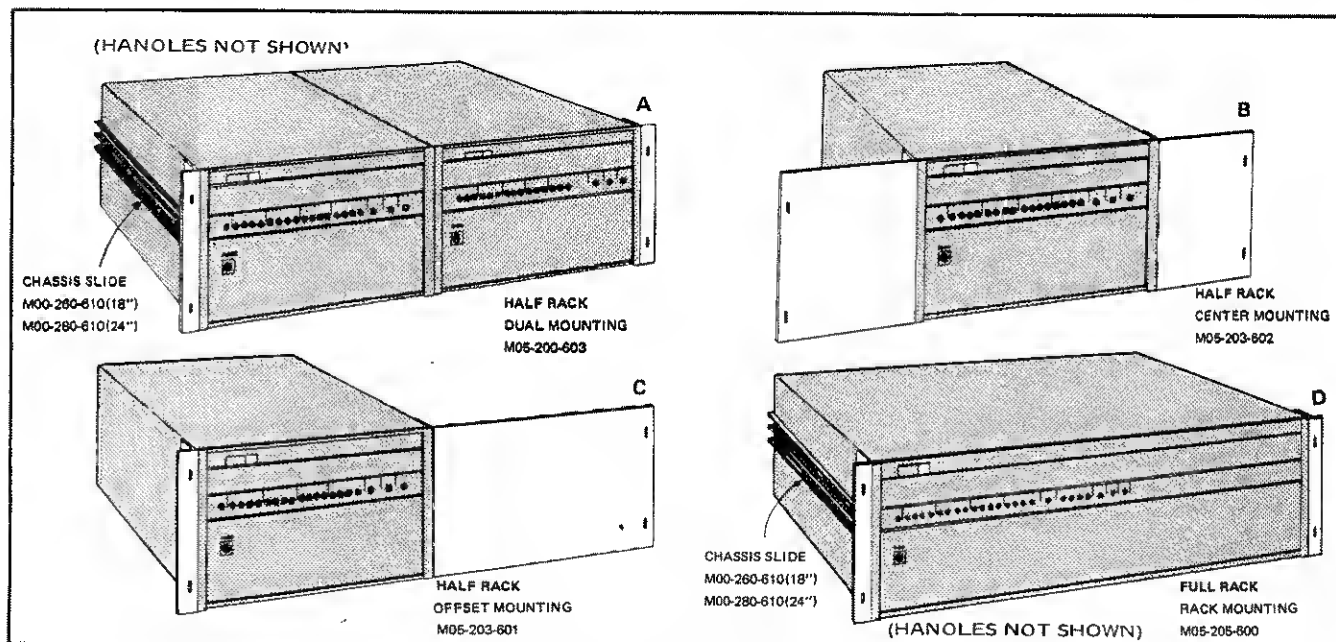

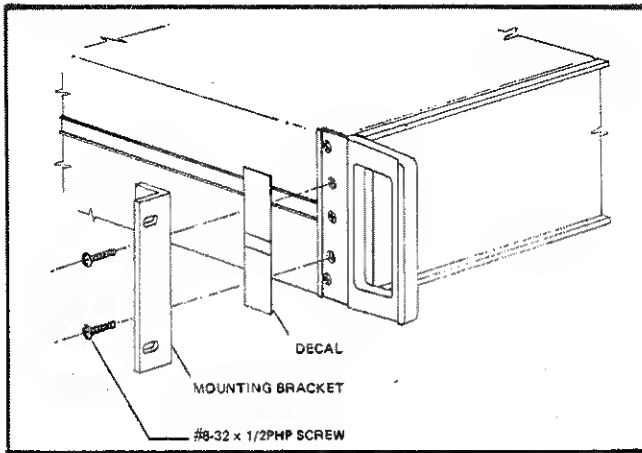Figure 6-1. ACCESSORY RACK MOUNTING KITS

Figure 6-2. RACK MOUNTING BRACKET INSTALLATION

d.   Remove the feet from the bottom dust cover.

e.   Slide the instrument into the equipment rack and secure it in place with fasteners through the mounting brackets.

NOTE!

Chassis slides should be installed on the full-rack width units. See Figure 6-1, A.

f.   Connect the power cord to line power.

6-6.   Half-Rack Dual Units Installation

6-7.   Two half-rack width instruments can be installed side-by-side in an equipment rack using the M05-200-603 Rack Mounting Kit. To install these components and mount the units in the equipment rack, proceed as follows:

a.   Ensure that the power cord of each instrument is disconnected from line power.

b.   Peel the front and rear side panel decals from each instrument.

c.   Select one instrument and remove the top and bottom dust covers.

d.   Remove the guard cover.

e.   Remove the three screws from the front side panel that will mate to the other instrument.

f.   Pull the front panel forward slightly and then thread the #8-32 fasteners into the P-nuts shown in Figure 6-3.

g.   Push the front panel into position, making sure that each PCB is correctly mated into the mother

board PCB, and then install the three screws in the front side panel.

h.   Thread the #8-32 fasteners into the P-nuts located on the inner rear side panel that will mate to the other instrument.

i.   Bolt the two instruments together as shown in Figure 6-3.

j.   Install the guard cover removed in step d.

k.   Remove the feet from the bottom dust cover of each instrument.

l.   Install the top and bottom dust covers removed in step b.

m.   Install the mounting brackets shown in Figure 6-2 on the outer front side panels. Use the #8-32 x 1/2" PHP screws provided in the kit.

n.   Slide the two instruments into the equipment rack and secure them in place with fasteners through the mounting brackets.

NOTE!

Refer to paragraph 6-8 for chassis slide installation.

o.   Connect the power cords to line power.

6-8.   Chassis Slide Installation

6-9.   The M00-260-610 (18") or M00-280-610 (24") Chassis Slide Kit should be installed to better facilitate dual rack mounting or installation of full-width rack units. To
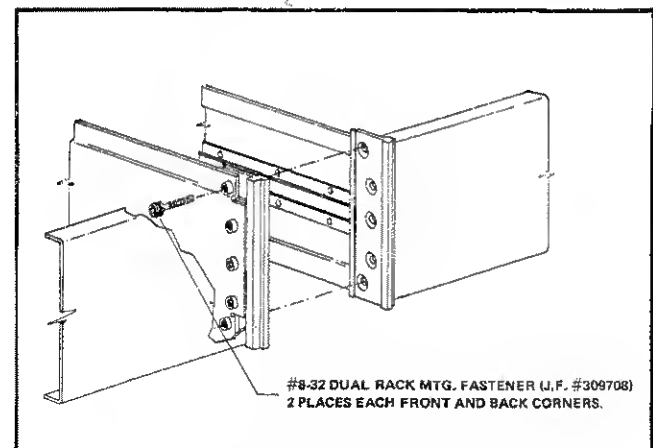
Figure 6-3. DUAL RACK MOUNTING

install these components and mount the units or unit in the equipment rack, proceed as follows:

a. Peel the center side panel decals from the instrument.

b. Peel the rear side panel decals from the instrument.

c. Remove the six screws from the rear panel corner brackets and then remove the brackets.

d. Slide the spacer (A) into the center section of the side panel until the tapped holes are aligned with the holes in the side panels.

e. Scribe a line on spacer where it protrudes from the rear of the side panel and then remove it from the instrument.

f. Cut off the spacer at the scribe mark and then install it in the side panel.

g. Install the rear panel corners.

h. Attach the chassis section (B) to the side panels with the screws (C) provided in the kit.

i. Install the cabinet sections (E) and center sections (D) in equipment rack. The extension angle brackets, which are part of section (E), are mounted at the rear of the cabinet.

j. Slide the center sections (D) toward the front of the cabinet until they lock in place.

k. Depress the spring locks on the chassis sections (B) and insert the instrument between the extended center sections (D) on the cabinet.

l. Slide the instrument completely into the equipment rack and secure in place with fasteners through the mounting brackets.
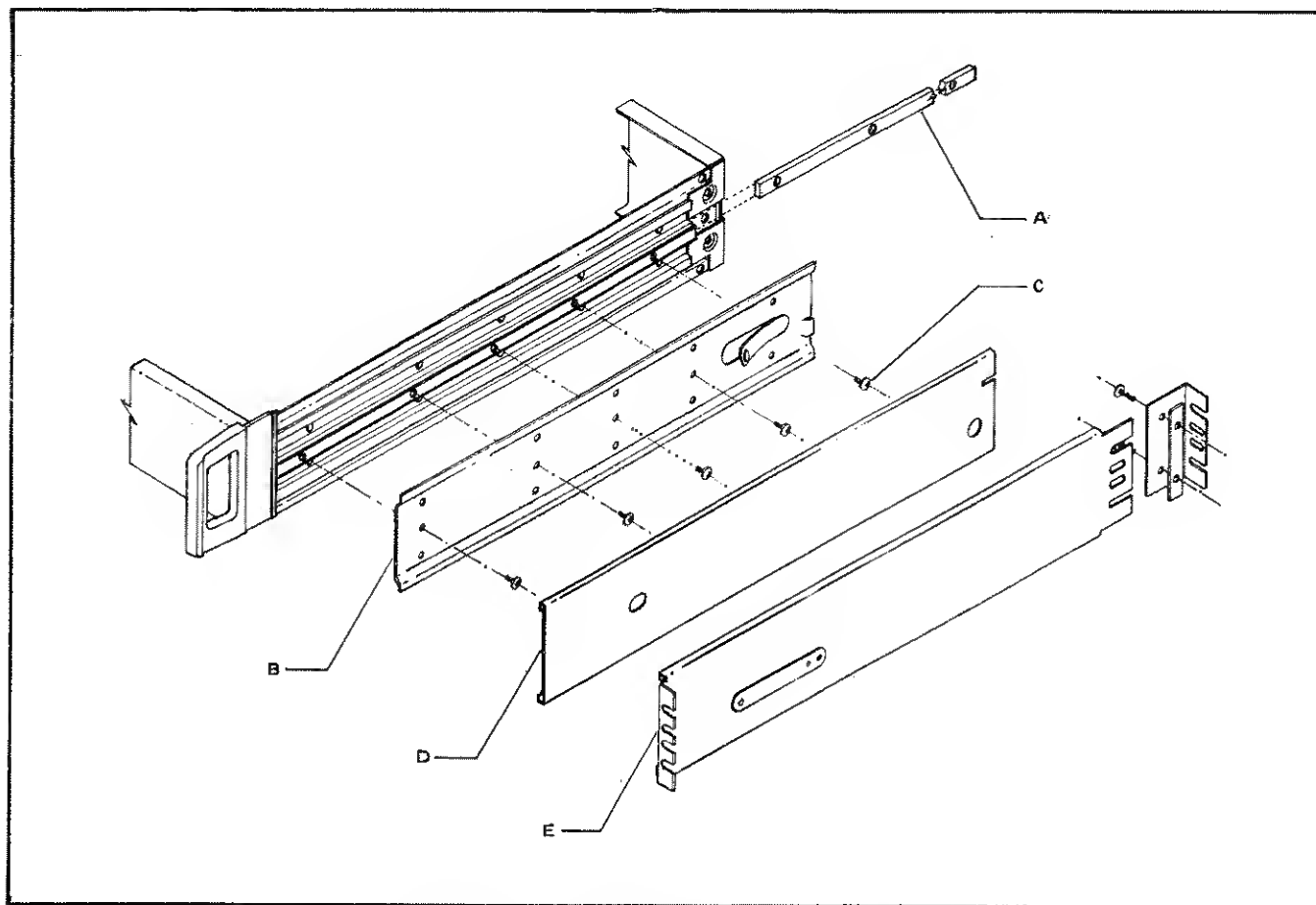
Figure 6-4. CHASSIS SLIDE INSTALLATION

Accessory
Programming Connector

6-1. INTRODUCTION

6-2.   The Amphenol, male, programming connector shown in Figure 6-1 is used to interface the instrument to a programming source. This male programming connector mates with the female programming connector that is mounted on the rear panel of the instrument. A male connector is normally supplied with each instrument, less cabling, but may also be ordered directly from Amphenol under PART NO. 57-30500, or from the John Fluke Mfg. Co., Inc., by referencing FLUKE PART NO. 266056.

6-3. ASSEMBLY INSTRUCTIONS

6-4.   Cabling connections to the male programming connector are done as follows:

a.   Remove the screws from the terminal cover of the male connector and remove the cover and numbered terminal/pin insert.

b.   Remove the screws from the restraining clamps on the cover and spread the clamps.

c.   Thread the cable wiring through the terminal cover. Maximum size is #22.

d.   Solder the wiring to the appropriate terminals of the numbered insert. Refer to Figure 6-1 for terminal locations. Use pin cover to support insert during soldering.

e.   Slide the covers together and install the attaching screws.

f.   Close the restraining clamp around the cable and install the screws. If necessary, wrap the wiring bundle to provide a proper diameter for the restraining clamp.

g.   Connect the male programming connector to the female connector on the rear panel of the instrument. Fasten them securely with the end clips.

Figure 6-1. MALE PROGRAMMING CONNECTOR

6-6. Cable Extender Assembly

a. The removal of certain interconnected printed circuit boards requires the use of a cable extender assembly to reconnect the board to its original electrical configuration after the board is inserted into the extender PCB. The cable extender assembly is shown in Figure 6-3, and is obtained by ordering FLUKE PART NO. 337584.

b. Usage of the cable extender assembly is shown in Figures 6-4 and 6-5 for the instruments requiring its use. Normally the cable extender assembly is not used with the 4210A/4216A instruments unless troubleshooting of the power supply PCB would require separating and remotely locating the ac input power controls and input transformer. The cable extender assembly would join the ac input power controls and input transformer to the power supply PCB.

c. After the extender PCB assembly and test PCB and, where required, the cable extender assembly are connected, the power can be applied.
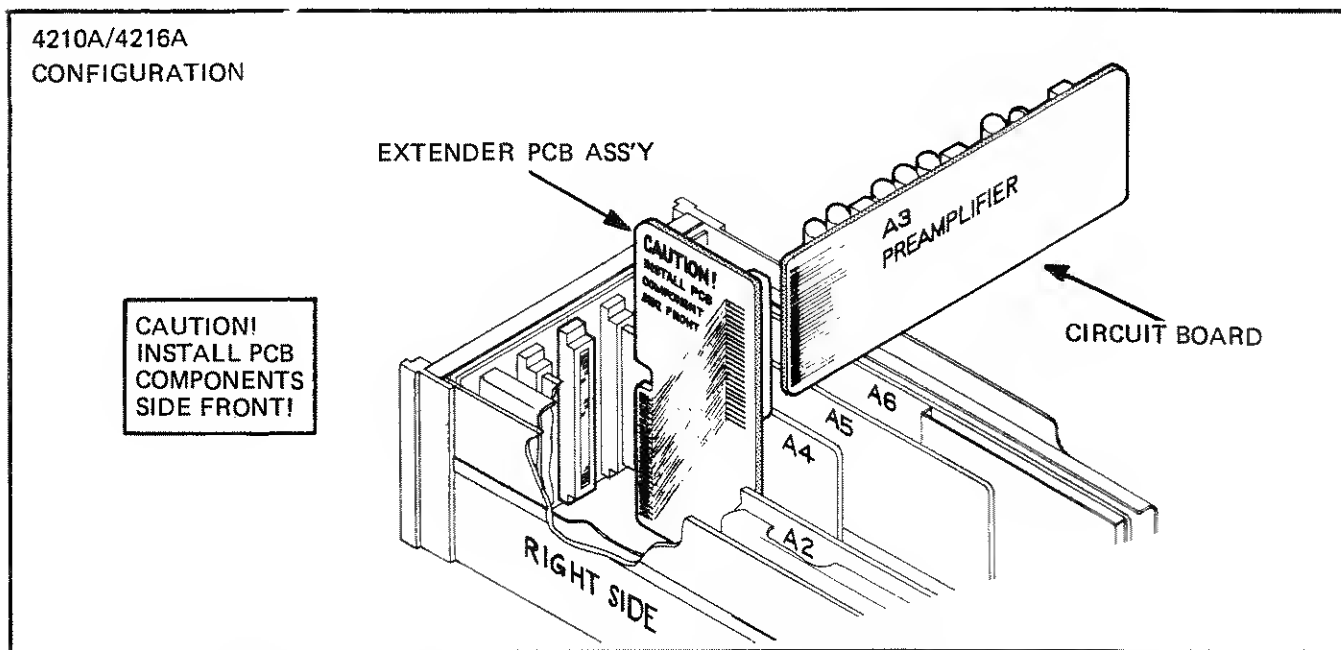
Figure 6-2. EXTENDER PCB ASSEMBLY INSTALLED IN 4210A/4216A INSTRUMENT

Figure 6-3. CABLE EXTENDER ASSEMBLY
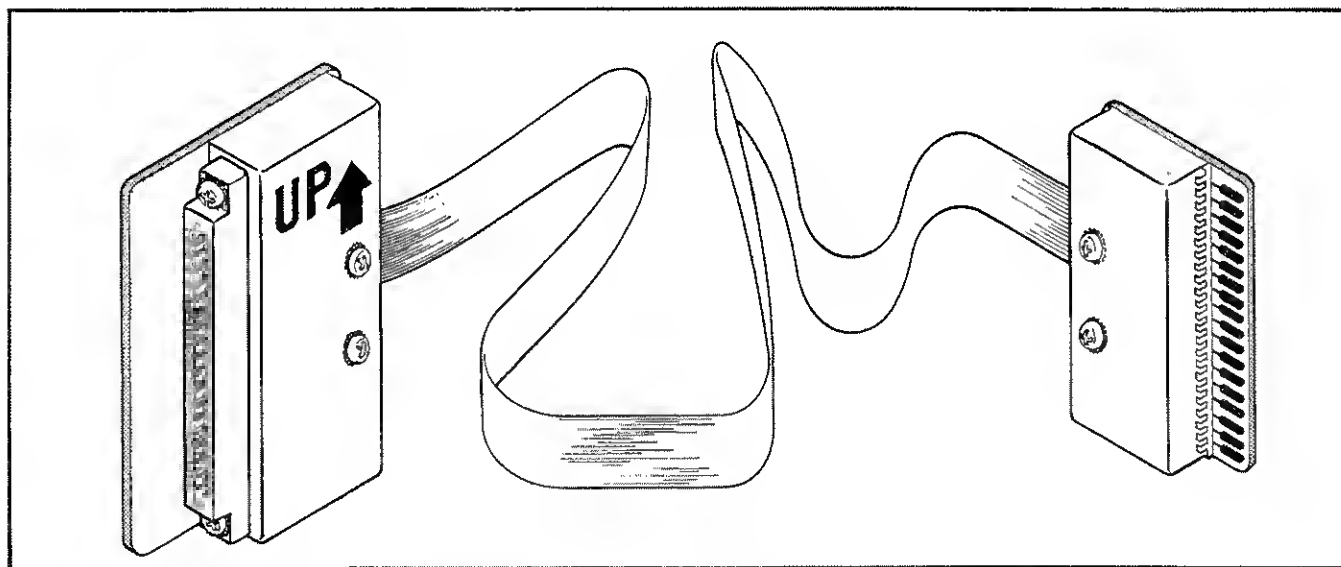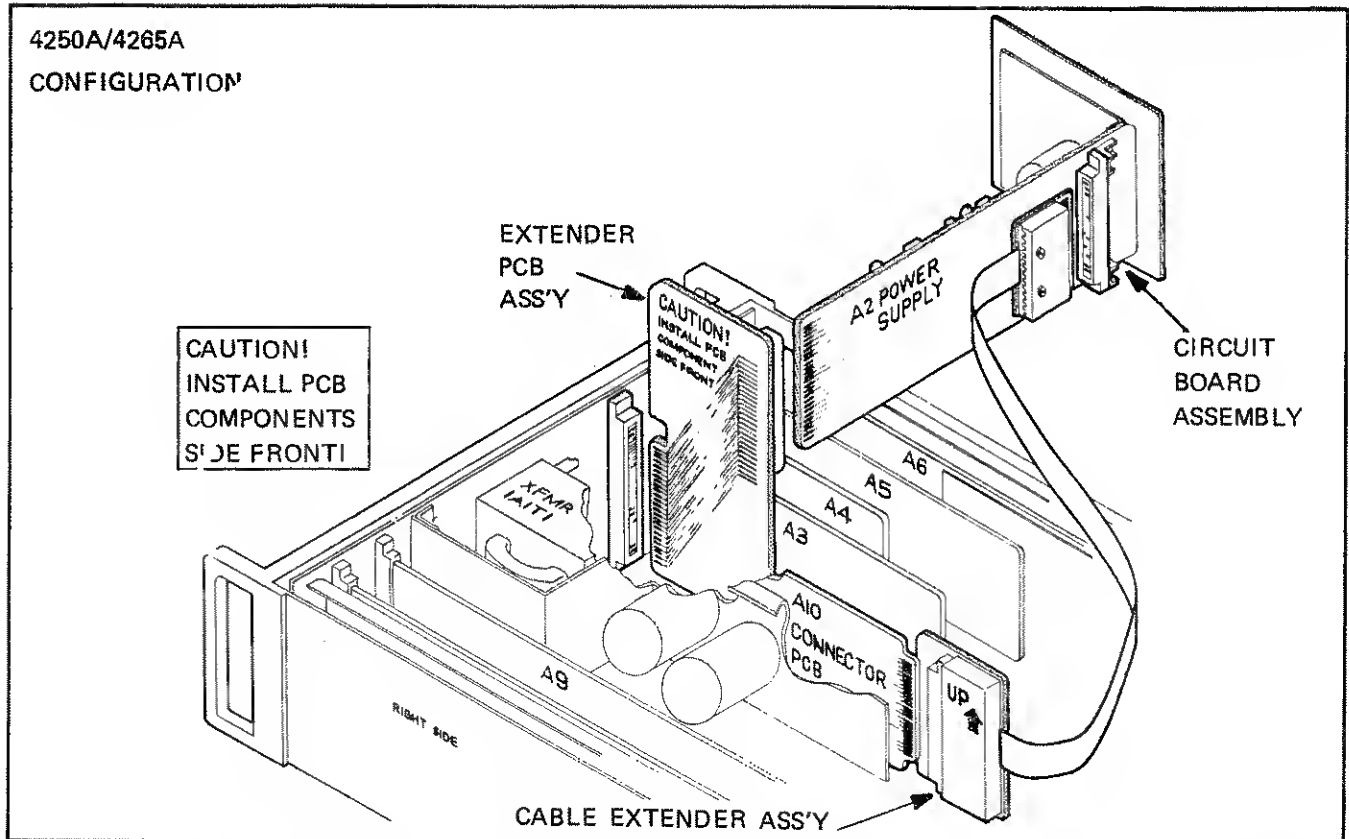
Figure 6-4. EXTENDER PCB AND CABLE EXTENDER ASSEMBLIES INSTALLED IN 4250A/4265A INSTRUMENTS
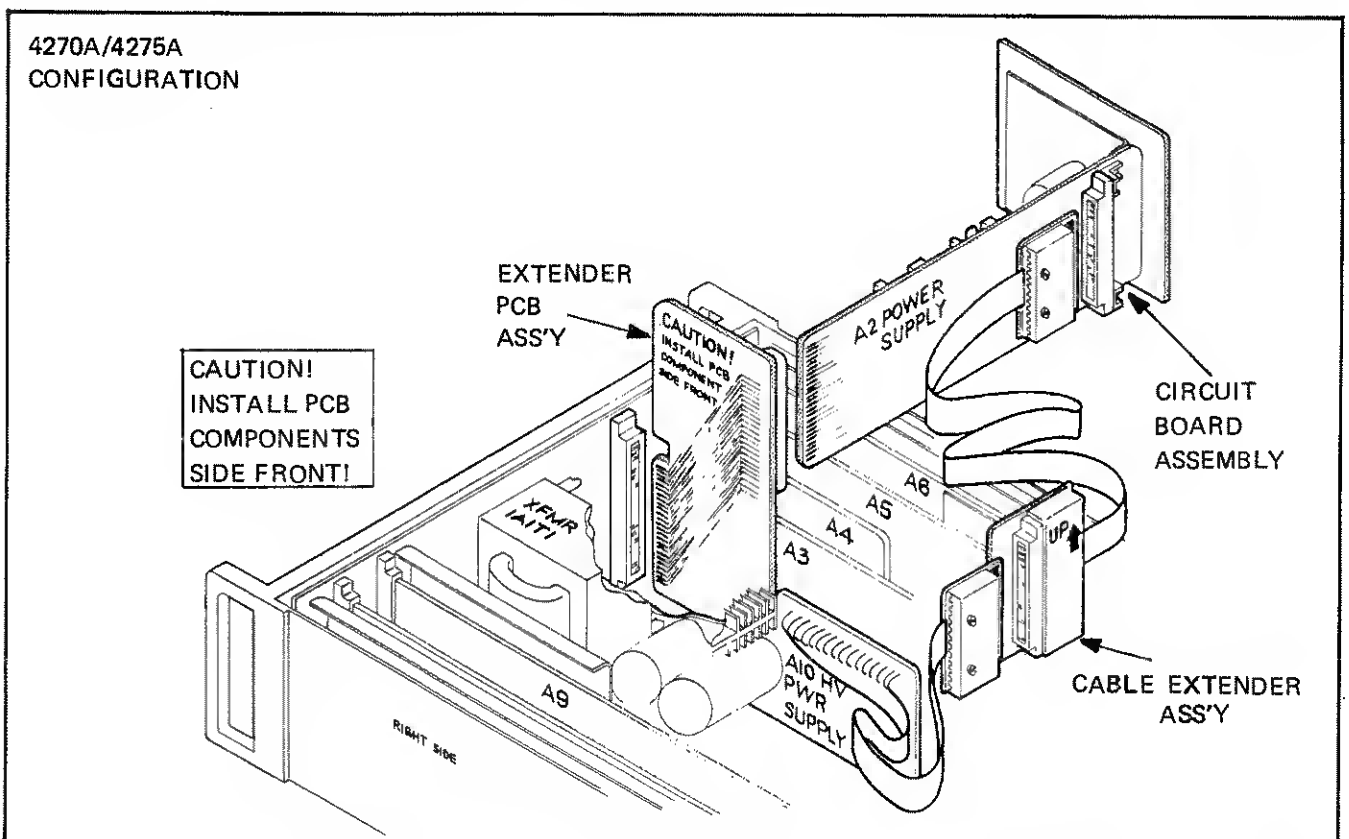

Figure 6-5. EXTENDER PCB AND CABLE EXTENDER ASSEMBLIES INSTALLED IN 4270A/4275A INSTRUMENTS

Section 7
General Information

7-1. This section of the manual contains generalized user information as well as supplemental information to the List of Replaceable Parts contained in Section 5.

List of Abbreviations and Symbols

A or amp	ampere	hf	high frequency	(+) or pos	positive
ac	alternating current	Hz	hertz	pot	potentiometer
af	audio frequency	IC	integrated circuit	p-p	peak-to-peak
a/d	analog-to-digital	If	intermediate frequency	ppm	parts per million
assy	assembly	in	inch(es)	PROM	programmable read-only
AWG	american wire gauge	intl	internal		memory
B	bel	I/O	input/output	psi	pound-force per square inch
bcd	binary coded decimal	k	kilo (10³)	RAM	random-access memory
°C	Celsius	kHz	kilohertz	rf	radio frequency
cap	capacitor	kΩ	kilohm(s)	rms	root mean square
ccw	counterclockwise	kV	kilovolt(s)	ROM	read-only memory
cer	ceramic	lf	low frequency	s or sec	second (time)
cermet	ceramic to metal(seal)	LED	light-emitting diode	scope	oscilloscope
ckt	circuit	LSB	least significant bit	SH	shield
cm	centimeter	LSO	least significant digit	SI	silicon
cmrr	common mode rejection ratio	M	mega (10⁶)	semo	serial number
comp	composition	m	milli (10⁻³)	sr	shift register
cont	continue	mA	milliampere(s)	Ta	tantalum
crt	cathode-ray tube	max	maximum	tb	terminal board
cw	clockwise	mf	metal film	tc	temperature coefficient or
d/a	digital-to-analog	MHz	megahertz		temperature compensating
dac	digital-to-analog converter	min	minimum	tcxo	temperature compensated
dB	decibel	mm	millimeter		crystal oscillator
dc	direct current	ms	millisecond	tp	test point
dmm	digital multimeter	MSB	most significant bit	u or μ	micro (10⁻⁶)
dvm	digital voltmeter	MSD	most significant digit	uhf	ultra high frequency
elect	electrolytic	MTBF	mean time between failures	us or μs	microsecond(s) (10⁻⁶)
ext	external	MTTR	mean time to repair	uut	unit under test
F	farad	mV	millivolt(s)	V	volt
°F	Fahrenheit	mv	multivibrator	v	voltage
FET	Field-effect transistor	MΩ	megohm(s)	var	variable
ff	flip-flop	n	nano (10⁻⁹)	vco	voltage controlled oscillator
freq	frequency	na	not applicable	vhf	very high frequency
FSN	federal stock number	NC	normally closed	vlf	very low frequency
g	gram	(−) or neg	negative	W	watt(s)
G	giga (10⁹)	NO	normally open	ww	wire wound
gd	guard	ns	nanosecond	xfmr	transformer
Ge	germanium	opnl ampl	operational amplifier	xstr	transistor
GHz	gigahertz	p	pico (10⁻¹²)	xtal	crystal
gmv	guaranteed minimum value	pare	paragraph	xtlo	crystal oscillator
gnd	ground	pcb	printed circuit board	Ω	ohm(s)
H	henry	pF	picofarad	μ	micro (10⁻⁶)
hd	heavy duty	pn	part number		

00213
Nytronics Comp. Group Inc.
Subsidiary of Nytronics Inc.
Formerly Sage Electronics
Rochester, New York

00327
Welwyn International, Inc.
Westlake, Ohio

00656
Aerovox Corp.
New Bedford, Massachusetts

00686
Film Capacitors, Inc.
Passaic, New Jersey

00779
AMP Inc.
Harrisburg, Pennsylvania

01121
Allen-Bradley Co.
Milwaukee, Wisconsin

01281
TRW Electronic Comp.
Semiconductor Operations
Lawndale, California

01295
Texas Instruments, Inc.
Semiconductor Group
Dallas, Texas

01537
Motorola Communications &
Electronics Inc.
Franklin Park, Illinois

01686
RCL Electronics Inc.
Manchester, New Hampshire

01730
Replaced by 73586

01884
Use 56289
Sprague Electric Co.
Dearborn Electronic Div.
Lockwood, Florida

02114
Ferroxcube Corp.
Saugerties, New York

02131
General Instrument Corp.
Harris ASW Div.
Westwood, Maine

02395
Rason Mfg. Co.
Brooklyn, New York

02533
Snelgrove, C.R. Co., Ltd.
Don Mills, Ontario, Canada
M3B 1M2

02606
Fenwal Labs
Div. of Travenal Labs.
Morton Grove, Illinois

02660
Bunker Ramo Corp., Conn Div.
Formerly Amphenol-Borg
Electric Corp.
Broadview, Illinois

02799
Areo Capacitors, Inc.
Chatsworth, California

03508
General Electric Co.
Semiconductor Products
Syracuse, New York

03814
Replaced by 71400

03651
Replaced by 44655

03797
Eldema Div.
Genisco Technology Corp.
Compton, California

03877
Transistron Electronic Corp.
Wakefield, Massachusetts

03888
KDI Pyrofilm Corp.
Whippany, New Jersey

03911
Clairex Electronics Div.
Clairex Corp.
Mt. Vernon, New York

03980
Muirhead Inc.
Mountainside, New Jersey

04009
Arrow Hart Inc.
Hartford, Connecticut

04062
Replaced by 72136

04202
Replaced by 81312

04217
Essex International Inc.
Wire & Cable Div.
Anaheim, California

04221
Aemco, Div. of
Midtex Inc.
Mankato, Minnesota

04222
AVX Ceramics Div.
AVX Corp.
Myrtle Beach, Florida

04423
Telonic Industries
Laguna Beach, California

04645
Replaced by 75376

04713
Motorola Inc. Semiconductor
Products
Phoenix, Arizona

04946
Standard Wire & Cable
Los Angeles, California

05082
Replaced by 94988

05236
Jonathan Mfg. Co.
Fullerton, California

05245
Components Corp. now
Corcom, Inc.
Chicago, Illinois

05277
Westinghouse Electric Corp.
Semiconductor Div.
Youngwood, Pennsylvania

05278
Replaced by 43543

05279
Southwest Machine &
Plastic Co.
Glendora, California

05397
Union Carbide Corp.
Materials Systems Div.
New York, New York

05571
Use 56289
Sprague Electric Co.
Pacific Div.
Los Angeles, California

05574
Viking Industries
Chatsworth, California

05704
Replaced by 16258

05820
Wakefield Engineering Inc.
Wakefield, Massachusetts

06001
General Electric Co.
Electronic Capacitor &
Battery Products Dept.
Columbia, South Carolina

06136
Replaced by 63743

06383
Panduit Corp.
Tinley Park, Illinois

06473
Bunker Ramo Corp.
Amphenol SAMS Div.
Chatsworth, California

06555
Beede Electrical Instrument Co.
Penacook, New Hampshire

06739
Electron Corp.
Littleton, Colorado

06743
Clevite Corp.
Cleveland, Ohio

06751
Components, Inc. Semcor Div.
Phoenix, Arizona

06860
Gould Automotive Div.
City of Industry, California

06961
Vernitron Corp., Piezo
Electric Div.
Formerly Clevite Corp., Piezo
Electric Div.
Bedford, Ohio

06980
Eimac Div.
Varian Associates
San Carlos, California

07047
The Ross Milton Co.
South Hampton, Pennsylvania

07115
Replaced by 14674

07138
Westinghouse Electric Corp.,
Electronic Tube Div.
Horsehead, New York

07233
TRW Electronic Components
Cinch Graphic
City of Industry, California

07256
Silicon Transistor Corp.
Div. of BBF Group Inc.
Chelmsford, Massachusetts

07261
Aumet Corp.
Culver City, California

07263
Fairchild Semiconductor
Div. of Fairchild Camera
& Instrument Corp.
Mountain View, California

07344
Bircher Co., Inc.
Rochester, New York

07597
Burndy Corp.
Tape/Cable Div.
Rochester, New York

07792
Lerma Engineering Corp.
Northampton, Massachusetts

07910
Teledyne Semiconductor
Formerly Continental Device
Hawthorne, California

07933
Use 49956
Raytheon Co.
Semiconductor Div. HO
Mountain View, California

08225
Industro Transistor Corp.
Long Island City, New York

08261
Spectra Strip Corp.
Garden Grove, California

08530
Reliance Mica Corp.
Brooklyn, New York

08806
General Electric Co.
Miniature Lamp Products Dept
Cleveland, Ohio

08883
Nylomatic Corp.
Norrisville, Pennsylvania

08988
Use 53085
Skottie Electronics Inc.
Archbald, Pennsylvania

09214
G.E. Co. Semi-Conductor
Products Dept.
Power Semi-Conductor
Products OPN Sec.
Auburn, New York

09353
C and K Components
Watertown, Massachusetts

09423
Scientific Components, Inc.
Santa Barbara, California

09922
Burndy Corp.
Norwalk, Connecticut

09969
Dale Electronics Inc.
Yankton, S. Dakota

10059
Barker Engineering Corp.
Formerly Amerace, Amerace
ESNA Corp.
Kenilworth, New Jersey

11236
CTS of Berne
Berne, Indiana

11237
CTS Keene Inc.
Paso Robles, California

11358
CBS Electronic Div.
Columbia Broadcasting System
Newburyport, Minnesota

11403
Best Products Co.
Chicago, Illinois

11503
Keystone Columbia Inc.
Warren, Michigan

11532
Teledyne Relays
Hawthorne, California

11711
General Instrument Corp.
Rectifier Division
Hicksville, New York

11726
Qualidyne Corp.
Santa Clara, California

12014
Chicago Rivet & Machine Co.
Bellwood, Illinois

12040
National Semiconductor Corp.
Danburry, Connecticut

12060
Diodes, Inc.
Chatsworth, California

12136
Philadelphia Handle Co.
Camden, New Jersey

12300
Potter-Brumfield Div.
AMF Canada LTD.
Guelph, Ontario, Canada

12323
Presin Co., Inc.
Shelton, Connecticut

12327
Freeway Corp. formerly
Freeway Washer & Stamping Co.
Cleveland, Ohio

12443
The Budd Co. Polychem Products
Plastic Products Div.
Bridgeport, Pennsylvania

12615
U.S. Terminals Inc.
Cincinnati, Ohio

12617
Hamlin Inc.
Lake Mills, Wisconsin

12697
Clarostat Mfg. Co.
Dover, New Hampshire

12749
James Electronics
Chicago, Illinois

12856
Micrometals
Sierra Madre, California

12954
Dickson Electronics Corp.
Scottsdale, Arizona

12969
Unitrode Corp.
Watertown, Massachusetts

13103
Thermalloy Co., Inc.
Dallas, Texas

13327
Solitron Devices Inc.
Tappan, New York

13511
Amphenol Cadre Div.
Bunker-Ramo Corp.
Los Gatos, California

13606
Use 56289
Sprague Electric Co.
Transistor Div.
Concord, New Hampshire

13839
Replaced by 23732

14099
Semtech Corp.
Newbury Park, California

14140
Edison Electronic Div.
Mc Gray-Edison Co.
Manchester, New Hampshire

14193
Cal-R-Inc. formerly
California Resistor, Corp.
Santa Monica, California

14298
American Components, Inc.
an Insilco Co.
Conshohocken, Pennsylvania

14655
Cornell-Dublier Electronics
Division of Federal Pacific
Electric Co. Govt. Control Dept.
Newark, New Jersey

14752
Electro Cube Inc.
San Gabriel, California

14869
Replaced by 96853

14936
General Instrument Corp.
Semi Conductor Products Group
Hicksville, New York

15636
Elec-Troi Inc.
Saugus, California

15801
Fenwal Electronics Inc.
Div. of Kidde Walter and Co., Inc.
Framingham, Massachusetts

15818
Teledyne Semiconductors,
formerly Amelco Semiconductor
Mountain View, California

15849
Litton Systems Inc. Useco Div.
formerly Useco Inc.
Van Nuys, California

15898
International Business
Machines Corp.
Essex Junction, Vermont

15909
Replaced by 14140

16258
Space-Lok Inc.
Burbank, California

16299
Corning Glass
Electronic Components Div.
Raleigh, North Carolina

16332
Replaced by 28478

16473
Cambridge Scientific Ind.
Div. of Chemed Corporation
Cambridge, Maryland

16742
Paramount Plastics
Fabricators, Inc.
Downey, California

16758
Delco Electronics
Div. of General Motors Corp.
Kokomo, Indiana

17001
Replaced by 71468

17069
Circuit Structures Lab.
Burbank, California

17338
High Pressure Eng. Co., Inc.
Oklahoma City, Oklahoma

17545
Atlantic Semiconductors, Inc.
Asbury Park, New Jersey

17856
Siliconix, Inc.
Santa Clara, California

17870
Replaced by 14140

18178
Vactec Inc.
Maryland Heights, Missouri

18324
Signetics Corp.
Sunnyvale, California

18612
Vishay Resistor Products Div.
Vishay Intertechnology Inc.
Malvern, Pennsylvania

18736
Voltronics Corp.
Hanover, New Jersey

18927
GTE Sylvania Inc.
Precision Material Group
Parts Division
Titusville, Pennsylvania

19451
Perine Machinery & Supply Co.
Seattle, Washington

19701
Electro-Midland Corp.
Mepco-Electra Inc.
Mineral Wells, Texas

20584
Enochs Mfg. Inc.
Indianapolis, Indiana

20891
Self-Organizing Systems, Inc.
Dallas, Texas

21604
Bucheye Stamping Co.
Columbus, Ohio

21845
Solitron Devices Inc.
Transistor Division
Riveria Beach, Florida

22767
ITT Semiconductors
Palo Alto, California

23050
Product Comp. Corp.
Mount Vernon, New York

23732
Tracor Inc.
Rockville, Maryland

23880
Stanford Applied Engrng.
Santa Clara, California

23936
Pamotor Div., Wm. J. Purdy Co.
Burlingame, California

24248
Replaced by 94222

24355
Analog Devices Inc.
Norwood, Massachusetts

24655
General Radio
Concord, Massachusetts

24759
Lenox-Fugle Electronics Inc.
South Plainfield, New Jersey

25088
Siemen Corp.
Isilen, New Jersey

25403
Amperex Electronic Corp.
Semiconductor &
Micro-Circuits Div.
Slatersville, Rhode Island

27014
National Semiconductor Corp.
Santa Clara, California

27264
Molex Products
Downers Grove, Illinois

28213
Minnesota Mining & Mfg. Co.
Consumer Products Div.
St. Paul, Minnesota

28425
Serv-/-Link formerly
Bohannan Industries
Fort Worth, Texas

28478
Deltrol Controls Div.
Deltrol Corporation
Milwaukee, Wisconsin

28480
Hewlett Packard Co.
Corporate HQ
Palo Alto, California

28520
Heyman Mfg. Co.
Kenilworth, New Jersey

29083
Monsanto, Co., Inc.
Santa Clara, California

29604
Stackpole Components Co.
Raleigh, North Carolina

30148
AB Enterprise Inc.
Ahoskie, North Carolina

30323
Illinois Tool Works, Inc.
Chicago, Illinois

31091
Optimax Inc.
Colmar, Pennsylvania

32539
Mura Corp.
Great Neck, New York

32767
Griffith Plastic Corp.
Burlingame, California

32879
Advanced Mechanical
Components
Northridge, California

32897
Erie Technological Products, Inc.
Frequency Control Div.
Carlisle, Pennsylvania

32997
Bourns Inc.
Trimpot Products Division
Riverside, California

33173
General Electric Co.
Products Dept.
Owensboro, Kentucky

34333
Silicon General
Westminister, California

34335
Advanced Micro Devices
Sunnyvale, California

34802
Electromotive Inc.
Kenilworth, New Jersey

37942
P.R. Mallory & Co., Inc.
Indianapolis, Indiana

42498
National Radio
Melrose, Massachusetts

43543
Nytronics Inc.
Transformer Co. Div.
Geneva, New York

44655
Ohmite Mfg. Co.
Skokie, Illinois

49671
RCA Corp.
Naw York, New York

49956
Raytheon Company
Lexington, Massachusetts

50088
Mostek Corp.
Carrollton, Texas

50579
Litronix Inc.
Cupertino, California

51605
Scientific Components Inc.
Linden, New Jersey

53021
Sangamo Electric Co.
Springfield, Illinois

54294
Cutler-Hammer Inc. formerly
Shallcross, A Cutter-Hammer Co.
Selma, North Carolina

55026
Simpson Electric Co.
Div. of Am. Gage and Mach. Co.
Elgin, Illinois

56289
Sprague Electric Co.
North Adams, Massachusetts

58474
Superior Electric Co.
Bristol, Connecticut

60399
Torin Corp. formerly
Torrington Mfg. Co.
Torrington, Connecticut

63743
Ward Leonard Electric Co., Inc.
Mount Vernon, New York

64834
West Mfg. Co.
San Francisco, California

65092
Weston Instruments Inc.
Newark, New Jersey

66150
Winslow Tele-Tronics Inc.
Eaton Town, New Jersey
70485
Atlantic India Rubber Works
Chicago, Illinois

70563
Amperite Company
Union City, New Jersey

70903
Belden Corp.
Geneva, Illinois

71002
Birnback Radio Co., Inc.
Freeport, New York

71400
Bussmann Mfg.
Div. of McGraw-Edison Co.
Saint Louis, Missouri

71450
CTS Corp.
Elkhart, Indiana

71468
ITT Cannon Electric Inc.
Santa Ana, California

71482
Clare, C.P. & Co.
Chicago, Illinois

71590
Centrelab Electronics
Div. of Globe Union Inc.
Milwaukee, Wisconsin

71707
Coto Coil Co., Inc.
Providence, Rhode Island

71744
Chicago Miniature Lamp Works
Chicago, Illinois

71785
TRW Electronics Components
Cinch Connector Operations Div.
Elk Grove Village
Chicago, Illinois

72005
Wilber B. Driver Co.
Newark, New Jersey

72092
Replaced by 06980

72136
Electro Motive Mfg. Co.
Williamantic, Connecticut

72259
Nytronics Inc.
Pelham Manor, New Jersey

72619
Dialight Div.
Amperex Electronic Corp.
Brooklyn, New York

72653
G.C. Electronics
Div. of Hydrometals, Inc.
Brooklyn, New York

72665
Replaced by 90303
72794
Dzus Fastener Co., Inc.
West Islip, New York

72928
Gulton Ind. Inc.
Gudeman Div.
Chicago, Illinois

72982
Erie Tech. Products Inc.
Erie, Pennsylvania

73138
Bechman Instrument Inc.
Helipot Division
Fullerton, California

73293
Hughes Aircraft Co.
Electron Dynamics Div.
Torrence, California

73445
Amperex Electronic Corp.
Hicksville, New York

73559
Carling Electric Inc.
West Hartford, Connecticut

73586
Circle F Industries
Trenton, New Jersey

73734
Federal Screw Products, Inc.
Chicago, Illinois

73743
Fischer Special Mfg. Co.
Cincinnati, Ohio

73899
JFD Electronics Co.
Components Corp.
Brooklyn, New York

73949
Guardian Electric Mfg. Co.
Chicago, Illinois

74199
Quan Nichols Co.
Chicago, Illinois

74217
Radio Switch Corp.
Marlboro, New Jersey

74276
Signalite Div.
General Instrument Corp.
Neptune, New Jersey

74306
Piezo Crystal Co.
Carlisle, Pennsylvania

74542
Hoyt Elect. Instr. Works
Penacook, New Hampshire

74970
Johnson E.F., Co.
Wasece, Minnesota

75042
TRW Electronics Components
IRC Fixed Resistors
Philadelphia, Pennsylvania

75378
Kurz-Kasch Inc.
Dayton, Ohio

75378
CTS Knights Inc.
Sandwich, Illinois

75382
Kulka Electric Corp.
Mount Vernon, New York

75915
Littlefuse Inc.
Oes Plaines, Illinois

76854
Oak Industries Inc.
Switch Div.
Crystal Lake, Illinois

77342
AMF Inc.
Potter & Brumfield Div.
Princeton, Indiana

77638
General Instrument Corp.
Rectifier Division
Brooklyn, New York

77969
Rubbercraft Corp. of CA. LTD.
Torrance, California

78189
Shekeproof
Div. of Illinois Tool Works Inc.
Elgin, Illinois

78277
Sigma Instruments, Inc.
South Braintree, Massachusetts

78488
Stackpole Carbon Co.
Saint Marys, Pennsylvania

78553
Eaton Corp. Engineered
Fastener Div.
Tinnerman Plant
Cleveland, Ohio

79138
Waldes Kohinoor Inc.
Long Island City, New York

79497
Western Rubber Company
Goshen, Indiana

79963
Zierick Mfg. Corp.
Mt. Kisko, New York

80031
Electro-Midland Corp.
Mepco Div.
A North American Phillips Co.
Norristown, New Jersey

80145
LFE Corp., Process Control Div.
formerly API Instrument Co.
Chesterland, Ohio

80183
Use 56289
Sprague Products
North Adams, Massachusetts

80294
Bourns Inc., Instrument Div.
Riverside, California

80583
Hammarlund Mfg. Co., Inc.
Red Bank, New Jersey

80640
Arnold Stevens, Inc.
South Boston, Massachusetts

81073
Grayhill, Inc.
La Grenge, Illinois

81312
Winchester Electronics
Olv. of Litton Industrles Inc.
Oakville, Connecticut

81483
Therm-O-Disc Inc.
Mansfield, Ohio

81483
International Rectifier Corp.
Los Angeles, California

81590
Korry Mfg. Co.
Seattle, Washington

81741
Chicago Lock Co.
Chicago, Illinois

82305
Palmer Electronics Corp.
South Gate, California

82389
Switchcraft Inc.
Chicago, Illinois

82415
North American Phillips
Controls Corp.
Frederick, Maryland

82872
Roanwell Corp.
New York, New York

82877
Rotron Inc.
Woodstock, New York

82879
ITT Royal Electric Div.
Pawtucket, Rhode Island

83003
Vero Inc.
Garland, Texas

83058
The Carr Co., United Can Div.
of TRW
Cambridge, Massachusetts

83298
Bendix Corp.
Electric Power Div.
Eatontown, New Jersey

83330
Herman H. Smith, Inc.
Brooklyn, New York

83478
Rubbercraft Corp.
of America, Inc.
West Haven, Connecticut

83594
Burroughs Corp.
Electronic Components Div.
Plainfield, New Jersey

83740
Union Carbide Corp.
Battery Products Div.
formerly Consumer Products Div.
New York, New York

84171
Arco Electronics
Great Neck, New York

84411
TRW Electronic Components
TRW Capacitors
Ogailala, Nebraska

84613
Fuse Indicator Corp.
Rockville, Maryland

84682
Essex International Inc.
Industrial Wire Div.
Peabody, Massachusetts

86577
Precision Metal Products
of Malden Inc.
Stoneham, Massachusetts

86684
Radio Corp. of America
Electronic Components Div.
Harrison, New Jersey

86928
Seastrom Mfg. Co., Inc.
Glendale, California

87034
Illuminated Products Inc.
Subsidiary of Oak Industries Inc.
Anahiem, California

88219
Gould Inc.
Industrial Div.
Trenton, New Jersey

88245
Litton Systems Inc.
Useco Div.
Van Nuys, California

88419
Cornell-Dubilier Electronic Div.
Federal Pacific Co.
Fuquay-Varian, North Carolina

88486
Plastic Wire & Cable
Jewitt City, Connecticut

88690
Replaced by 04217

89536
John Fluke Mfg. Co., Inc.
Seattle, Washington

89730
G.E. Co., Newark Lamp Works
Newark, New Jersey

90201
Mallory Capacitor Co.
Div. of P.R. Mallory Co., Inc.
Indianapolis, Indiana

90211
Use 56365
Square D Co.
Chicago, Illinois

90215
Best Stamp & Mfg. Co.
Kansas City, Missouri

90303
Mallory Battery Co.
Div. of Mallory Co., Inc.
Tarrytown, New York

91094
Essex International Inc.
Suglex/IWP Div.
Newmarket, New Hampshire

91293
Johanson Mfg. Co.
Boonton, New Jersey

91407
Replaced by 58474

91502
Associated Machine
Santa Clara, California

91506
Augat Inc.
Attleboro, Massachusetts

91637
Dale Electronics Inc.
Columbus, Nebraska

91662
Elco Corp.
Willow Grove, Pennsylvania

91737
Use 71468
Gremar Mfg. Co., Inc.
ITT Cannon/Gremar
Santa Ana, California

91802
Industrial Devices, Inc.
Edgewater, New Jersey

91833
Keystone Electronics Corp.
New York, New York

91836
King's Electronics Co., Inc.
Tuckahoe, New York

91929
Honeywell Inc.
Micro Switch Div.
Freeport, Illinois

91934
Miller Electric Co., Inc.
Div. of Aunet
Woonsocket, Rhode Island

92194
Alpha Wire Corp.
Elizabeth, New Jersey

93332
Sylvania Electric Products
Semiconductor Products Div.
Woburn, Massachusetts

94145
Replaced by 49956

94154
Use 94988
Wagner Electric Corp.
Tung-Sol Div.
Newark, New Jersey

94222
Southco Inc. formerly
South Chester Corp.
Lester, Pennsylvania

95146
Alco Electronic Products Inc.
Lawrence, Massachusetts

95263
Leecraft Mfg. Co.
Long Island City, New York

95264
Replaced by 98278

95275
Vitramon Inc.
Bridgeport, Connecticut

95303
RCA Corp.
Receiving Tube Div.
Cincinnati, Ohio

95348
Gordo's Corp.
Bloomfield, New Jersey

95354
Methode Mfg. Corp.
Rolling Meadows, Illinois

95712
Bendix Corp.
Electrical Components Div.
Microwave Devices Plant
Franklin, Indiana

95967
Weckesser Co. Inc.
Chicago, Illinois

96733
San Fernando Electric Mfg. Co.
San Fernando, California

96853
Gulton Industries Inc.
Measurement and Controls Div.
formerly Rustrak Instruments Co.
Manchester, New Hampshire

96881
Thomson Industries, Inc.
Manhasset, New York

97540
Master Mobile Mounts, Div. of
Whitehall Electronics Corp.
Ft. Meyers, Florida

97913
Industrial Electronic
Hardware Corp.
New York, New York

97945
Penwalt Corp.
SS White Industrial Products Div.
Piscataway, New Jersey

97966
Replaced by 11358

98094
Replaced by 49956

98159
Rubber-Teck, Inc.
Gardena, California

98278
Malco A Microdot Co., Inc.
Connector & Cable Div.
Pasadena, California

98291
Sealectro Corp.
Mamaroneck, New York

98388
Royal Industries
Products Div.
San Diego, California

98743
Replaced by 12749

98925
Replaced by 14433

99120
Plastic Capacitors, Inc.
Chicago, Illinois

99217
Bell Industries Elect.
Comp. Div.
formerly Southern Elect. Div.
Burbank, California

99392
STM
Oakland, California

99515
ITT Jennings Monrovia Plant
Div. of ITT Jennings formerly
Marshall Industries Capacitor Div.
Monrovia, California

99779
Use 29587
Bunker-Ramo Corp.
Barnes Div.
Landsdowne, Pennsylvania

99800
American Precision Industries Inc.
Delevan Division
East Aurora, New York

99942
Centrelab Semiconductor
Centrelab Electronics Div. of
Globe-Union Inc.
El Monte, California

Toyo Electronics
(R-Ohm Corp.)
Irvine, California

National Connector
Minneapolis, Minnesota

U.S. SALES AREAS for all Fluke products

AL, Huntsville
John Fluke Mfg. Co., Inc.
3322 S. Memorial Parkway
Suite 96
Huntsville, AL 35801
(205) 881-6220

AZ, Tempe
John Fluke Mfg. Co., Inc.
2211 S. 48th Street
Suite B
Tempe, AZ 85282
(602) 438-8314

Tucson
(602) 790-9881

CA, Irvine
P.O. Box 19676
Irvine, CA 92713
16969 Von Karman
Suite 100
Irvine, CA 92714
(714) 863-9031

Los Angeles
John Fluke Mfg. Co., Inc.
20902 South Bonita St.
Carson, CA 90746
(213) 538-3900

San Diego
John Fluke Mfg. Co., Inc.
4540 Kearny Villa Rd., Suite 115
San Diego, CA 92123
(619) 292-7656

Santa Clara
John Fluke Mfg. Co., Inc.
2300 Walsh Ave., Bldg. K
Santa Clara, CA 95051
(408) 727-0513

CO, Denver
John Fluke Mfg. Co., Inc.
1980 South Quebec St. #4
Denver, CO 80231
(303) 750-1222

CT, Hartford
John Fluke Mfg. Co., Inc.
Glen Lochen East
41-C New London Turnpike
Glastonbury, CT 06033
(203) 659-3541

FL, Orlando
John Fluke Mfg. Co.,Inc.
940 N. Fern Creek Ave.
Orlando, FL 32803
(305) 896-4881

GA, Atlanta
John Fluke Mfg. Co., Inc.
2700 Delk Rd., Suite 250
Marietta, GA 30067
(404) 953-4747

IA, Iowa City
(319) 354-2611

IL, Chicago
John Fluke Mfg. Co., Inc.
3740 Industrial Ave.
Rolling Meadows, IL 80008
(312) 398-0850

IN, Indianapolis
John Fluke Mfg. Co., Inc.
8777 Purdue Road
Suite 101
Indianapolis, IN 46268
(317) 875-7870

KS, Kansas City
(913) 381-9800

LA, New Orleans
(504) 455-0814

MA, Burlington
John Fluke Mfg. Co., Inc.
25 "B" Street
Burlington MA 01803
(617) 273-4674

MO, Baltimore
(301) 792-7060

Rockville
John Fluke Mfg. Co., Inc.
5640 Fishers Lane
Rockville, MD 20852
(301) 770-1570

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Spark Radio & Electronics Corp.
Tel: 775192, 704096
TLX: 27901 RLA PH

Portugal, Lisbon
Decada Espectral Equipamentos
de Electronica, Lda.
Tel: 2103420
TLX: 15515

Republic of Singapore, Singapora
Rank O'Connor's (PTE) Limited
Tel: 637944, 239052
TLX: RS21023 OCONSIN

Republic of South Africa, Wynberg
Fluke S.A. (Pty) Ltd.
Tel: 786-3170
TLX: 424328

Spain, Madrid
Equipos y Sistemas S.A.
Tel: 458-0150
TLX: 42856 EYS E

Sweden, Vallingby
Teleinstrument AB
Tel: 380370
TLX: 15770

Switzerland, Zurich
Traco Electronic AG
Tel: 2010711
TLX: 815570 TRCO CH

Taiwan, Taipei
Schmidt Electronics Corp.
Tel: 5013468
TLX: 11111 SCHMIDT
10548 EVERGOFT

Thailand, Bangkok
Measuretronix Ltd.
Tel: 378-2516
TLX: 81143 DEJOBKK TH

Turkey, Istanbul
Erkman Elektronik Aletler
Tel: 4415461
TLX: 24399

Uruguay, Montevideo
Coasin Uruguaya S.A.
Tel: 789015
TLX: UY6571 OROCUER SA

Venezuela, Caracas
Coasin C.A.
Tel: 239-0967, 239-5079
TLX: 21027 EMVEN VE

West Germany, Ismaning/Munich
Fluke (Deutschland) GmbH
Tel: 96050
TLX: 0522472

Section 8
Schematic Diagrams

REAR PANEL 1A

FAN 1AB1

BLACK HARDWIRING

A2TB1

TRANSFORMER 1A1T1

1A1J1   A10P1

1A1W1

A10W3

A10J3   A10P3

A10W2

THERMOSTATIC SWITCH A9S1

A10

Q1 - Q4 HEAT SINK

HEAT SINK A9

HIGH VOLTAGE POWER SUPPLY

HEAT SINK PCB A9A1

A9W1

A10W1

A9J1   A10P2

A8 CURRENT LIMITER -06 OPTION

A9A1J1 A9P2

A9 POWER AMPLIFIER

A10A1 CONN PCB

A2 POWER SUPPLY

A10A1P1   A2J1

PI

LOCKOUT JUMPER HARDWIRING

PI

PI   P2

PI

CHASSIS 1A

XA8P1

XA9P1

XA2P1

1A1A1   MOTH

WHITE HARDWIRING

A7   BCD ▷ DISPLAY OR BINAR

GUARD 1A1

NOTES:
1. ◁ MODEL 4270A CONFIGURATION.
2. ◁ MODEL 4275A CONFIGURATION.
3. --- INDICATES FIELD/FACTORY INSTALLABLE OPTION.

4. SOME REFERENCE DESIGNATORS ARE ABBREVIATED: I.E., A3
   SEE SECTION 5 LIST OF REPLACEABLE PARTS.

A7PI

BCD/BINARY

- A8/16384 — U1E — Q3 — R3 270 — R11 270 — Q11 — U2C — CB/64
- A4/8192 — U1D — Q4 — R4 270 — R12 270 — Q12 — U2B — C4/32
- A2/4096 — U1C — Q5 — R5 270 — R13 270 — Q13 — U2A — C2/16
- A1/2048 — U1B — Q6 — R6 270 — R14 270 — Q14 — U3F — C1/8
- B8/1024 — U1A — Q7 — R7 270 — R15 270 — Q15 — U3E — D8/4
- B4/512 — U2F — Q8 — R8 270 — R16 270 — Q16 — U3D — D4/2
- B2/256 — U2E — Q9 — R9 270 — R17 270 — Q17 — U3C — D2/1
- B1/128 — U2D — Q10 — R10 270 — R18 270 — Q18 — U3B — D1/0.5
- EXT REF — U5B — Q26 EXT REF — R26 270 — R21 270 — Q21 — U4A — L8(80mA)
- POLARITY — U1F — Q2 SIGN — R2 270 — R22 270 — Q22 — U5F — L4(40mA)
- LIMIT — U5C — Q25 I LIMIT — R25 270 — R23 270 — Q23 — U5E — L2(20mA)
- VR(VOLTAGE RANGE) — U4D — Q19 50VOLT RANGE — R19 270 — R24 270 — Q24 — U5D — L1(10mA)
- STANDBY — U5A — R27 270 — R20 270 — Q20 X10 — U4B — LR (CURRENT LIMIT X10)
- Q27 STBY
- R1 270 — Q1 POWER
- -VL
- -VL COMMON

A7PI

BCD/BINARY

XA8PI CURRENT LIMIT

XA9 POWER

LOCKOUT JUMPER

GUARD o — WHT HARD

NOTES:

1. LOGIC GRO
2. SOLDERABI
3. JUMPER TO LIMITER (-C
4. CONNECTOR JACK
5. LIGHT EMIT ON PCB.
6. XA7PI (CONN AT A7PI)

J1

+136VDC 1/A
COM 2/B
-136V DC 3/C

P1 +VH VH COMMON -VH
L 9/K 10

+23.4V R1 1K Q1
C1 0.05 C2 33pF R2 2.87K
U1

28V AC 4/D

+VA SUPPLY
Q12
Q13
R33 4.7
C9 33pF
R36 10K
R38 2.7K
U4
R6 13.7K
CR4
C19 33pF
R18 20K +A8
R17 20.02K C5 33pF R19 50K
U3
C7 250
R37 4.02K
CR9 +4.3V
C10 33pF
U5
R40 3.74K

28V AC 6/F

28V AC COMMON 5/E

NOT USED 9/K Z NC
11/M Z NC

R58 470
Q14
Q15
R39 4.7
R41 4.02K
-25.1V
R20 10K R60 470
-25.1V
-VA SUPPLY

8V AC 7/H 8/J

CR26
CR25
CR14
Q16
R45 470
Q17
R44 10K
+23.4V
Q18
C14 0.05
R47 3.74K
R46 17.4K
RELAY DR
R55 1K
R48 3.9K
C18 1.0
Q19
R49 470
-5V

GUARD 10/L Z GUARD

C13 8000
-5V
-25.1V -5V
-VL SUPPLY

8V AC 13/P 14/R

CR19
Q22
Q21
R53 470
Q23
CR23 4.3V
Q24
C17 0.05
R54 22
C16 8000
Z GUARD
+VL SUPPLY

A9S1 18
A10-S1A V
± 17,U
WHITE 115 VAC
RED 230 VAC
S1
R61 10
C22 1
OFF ON
S2 POWER SWITCH
F1
J1
A10-S1B 16,T
± 15,S
OFF ON
COMMON (CHASSIS) 12,N

NOTES:
1. ALL CAPACITANCE IN
   OHMS UNLESS OTHE
2. THE FOLLOWING P1 PIN
   C,E,H,J,M THRU R,T,
3. ▽ LOGIC GROU
4. ▽ COMMON
5. ⌇ PCB CONNECTO
6. ▽ REF COMMON
7. ⏚ EXTERNAL LOG
8. * SELECTED
9. ▷ POWER SUPPLY
10. ▷ VH COMMON A
    A1 LOCKOUT

Schematic diagram — LADDER & DRIVERS, LADDER CLAMPS

Partial labels visible:

HIGH Z

P1
VREF   C
VREF SENSE   3
VREF HIGH   D
+VA   X
-VA   20
- VA COMMON   B
              2
VREF COMMON   H

BCD LADDER INPUT 1

VR'   F
-VL COMMON 21
-VL   22
A8   18
A4   V
A2   17
A1   U

LADDER & DRIVERS

LADDER CLAMPS

|A|T|

VIO/W
BLU/W
YEL/W
ORN/W

ORN
135VAC
RED
135VAC
ORN

|A|J| A10P1
ORN ORN > A

R1 4.7K
CR1
CR2
C1 0.01

VIO
BLU
YEL
ORN

RED > 1

|A|W|

BRN
RED

GRN

YEL
BLK
BLU

ORN > B

CR3
CR4

VIO
GRY

WHT

YEL > C 28 VAC
BLK > D 28 VAC COMMON
BLU > 2 28VAC
VIO > 3 8VAC
GRY > 4 8VAC
WHT > E T1 OUTPUT SHIELD (GUARD)
GRN > 5 T1 INPUT SHIELD
RED > 6 8VAC
BRN > F 8VAC
ORN > 7 ±
YEL > 10 100VAC
BLU > 8 115VAC

VIO > J 125VAC
ORN/W > H ±
YEL/W > L 100VAC
BLU/W > 9 115VAC
VIO/W > K 125VAC

WHT

RED
S2

A10W3   P

H.V. POWER

REAR PANEL

FAN
|A8|

NOTES:

1. SWITCH LOGIC VS. LINE VOLTAGE

LINE VOLTAGE	SWITCH POSITIONS		
	PWR SPLY A2S1 *	H.V. POWER SUPPLY A10S1	A10S2
100	WHITE	WHITE	RED
115	WHITE	RED	WHITE
125	WHITE	RED	RED
200	RED	WHITE	RED
230	RED	RED	WHITE
250	RED	RED	RED

* A2S1 MOUNTED ON A2 POWER SUPPLY ASSEMBLY

2. ▷ Q1 AND Q4 CONNECTE

3. ALL RESISTANCE IN MICROPARA

4. /// *CHASSIS G